October 12, 1959

Aviation Week

Including Space Technology

Blue Steel Design Details

•

Short SC.1 Flight Tests

English Electric T.4 Jet Trainer

Predict Report on NACA Meeting

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A complete line of *Kaylock*® "Spaceweight" fasteners is available now for aerospace vehicles, electronics, engines.

FOR COMPETITIVE REASONS, reappraise your projects with an eye to "trimming off the fat." Send today for Kaynar's new full-line brochure of 160,000 psi. self-locking nuts.

H14 6-point Hex Nut

MF1400 Miniature Floating Anchor Nut

K2400 1-Lug Anchor Nut

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K1400 2-Lug Anchor Nut

MK4400 Miniature Short Lug Anchor Nut

G1400 Narrow Gang Channel

K3400 Corner Anchor Nut

MK2400 Miniature 1-Lug Anchor Nut

MK3400 Miniature Corner Anchor Nut

RG1231 Radius Gang Channel

H23 12-Point High Tensile Nut

H20 12-Point High Tensile Nut

H24 12-Point High Tensile Nut

H10 6-point Hex Nut

TENSILE STRENGTH
H10 meets requirements of MIL-N-25027, AN-N-5 and AN-N-10 (NAS679) (AN363, 364, 365) (MS21041) for use on 125,000psi. bolts and screws.

PART NO.	SERVICE TEMP.	TENSILE STRENGTH	MATERIAL
H14	550°F.	160,000psi.	Carbon Steel
MF1400	550°F.	160,000psi.	Carbon Steel
K2400	550°F.	160,000psi.	Carbon Steel
MK1400	550°F.	160,000psi.	Carbon Steel
F2400	550°F.	160,000psi.	Carbon Steel
F5400	550°F.	160,000psi.	Carbon Steel
K1400	550°F.	160,000psi.	Carbon Steel
MK4400	550°F.	160,000psi.	Carbon Steel
G1400	250°F.	160,000psi.	Nuts-Carb. Stl. Channel-Alum. Alloy
K3400	550°F.	160,000psi.	Carbon Steel
MK2400	550°F.	160,000psi.	Carbon Steel
MK3400	550°F.	160,000psi.	Carbon Steel
RG1231	1,200°F.	160,000psi.	Nuts-A286 CRES. Channel-321 CRES.
H23	550°F.	180,000psi.	Alloy Steel
H20	550°F.	180,000psi.	Alloy Steel
H24	550°F.	220,000psi.	Alloy Steel
H10	550°F.	125,000psi.	Carbon Steel

All configurations shown are available in A286 Stainless Steel for high temperature applications.

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RECOGNIZE THESE

three famous noses?

Clue: All are structural plastic radomes built by Goodyear Aircraft

THESE NOSES MAKE NEWS, for they belong to aircraft with vast capabilities—the Boeing B-52G, the Convair B-58 and the Lockheed C-130 (A and B). Strikingly different in shape and in the manufacturing methods they require, the nose radomes shown here are alike in several key ways. All are built to demanding specifications by Goodyear Aircraft Corporation. All provide exceptional thermal, structural and electrical properties.

THE SNUB-NOSED B-52G RADOME, employing a honeycomb-sandwich construction, is one of the largest sandwich-type radomes ever designed for use on a high-speed aircraft.

THE NEEDLE-NOSED B-58 RADOME, a solid laminate made of high-temperature-resistant resin, houses special equipment calling for one of the most dimensionally precise radomes ever fabricated.

THE LOW-SLUNG C-130 (A and B) RADOME, a cored deicer, is one of the first successful *ducted* radomes ever built.

AS A FABRICATOR, Goodyear Aircraft has the unique capability of manufacturing the entire plastic radome assembly, including metal attachment parts. Goodyear Aircraft also has extensive testing facilities. The result: radomes of remarkable strength which approach complete electromagnetic transparency.

THESE ADVANCED METHODS AND MATERIALS stem from Goodyear Aircraft's vast experience with all types and sizes of radomes—from small aircraft radomes to huge ground radomes (the largest: 140-foot diameter). Can this experience solve a problem for you? WRITE—for full information—to: Goodyear Aircraft Corporation, Dept. 916AJ, Akron 15, Ohio.

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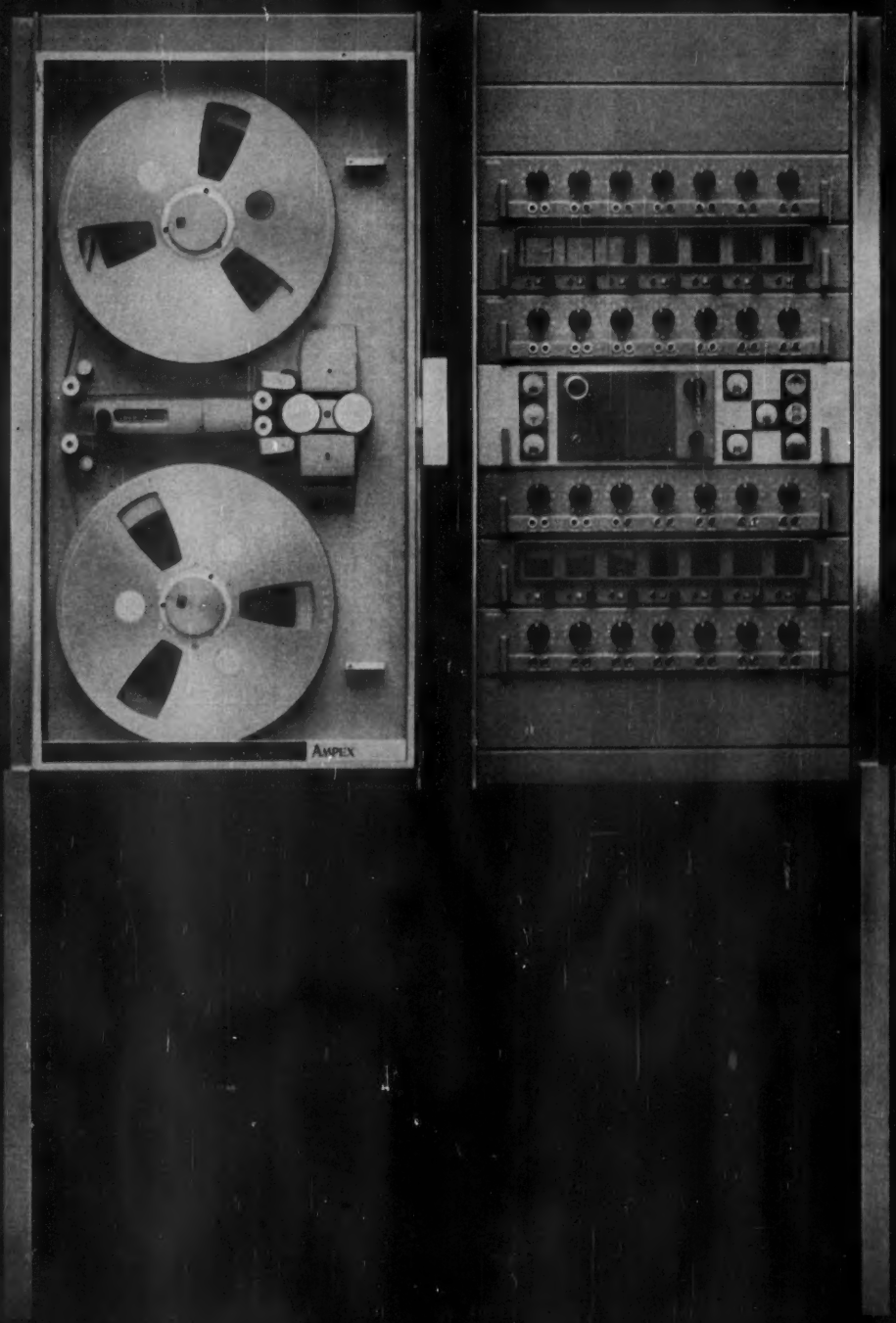

AVIATION CALENDAR

Oct. 19-20—15th Annual Convention, Magnesium Assn., Hotel Roosevelt, New York.

Oct. 19-21—11th Annual Machine Tool Conference, American Institute of Electrical Engineers, Sheraton-Cleveland Hotel, Cleveland, Ohio.

Oct. 19-23—47th National Safety Congress, National Safety Council, Conrad Hilton Hotel, Chicago, Ill.

Oct. 19-25—Annual Meeting, Aircraft Owners and Pilots Assn., Galt Ocean Mile Hotel, Fort Lauderdale, Fla.

Oct. 20-22—Tenth National Conference on Standards, American Standards Assn., Sheraton-Cadillac Hotel, Detroit, Mich.

Oct. 20-22—Sixth Annual Lubrication Conference, Sheraton-McAlpin Hotel, New York, N. Y. Sponsors: American Society of Lubrication Engineers; American Society of Mechanical Engineers.

Oct. 20-22—16th Seminar-Workshop in Visual Communication, Tecnifax Corp., Holyoke, Mass.

Oct. 21-23—1959 Annual Meeting, Society for Experimental Stress Analysis, Pick Fort Shelby Hotel, Detroit, Mich.

Oct. 22-23—Fall Meeting, Northeast Chapter of American Assn. of Airport Executives, Bradley Field, Windsor Locks, Conn.

Oct. 22-24—1959 Meeting and special "Cavitation" session, Acoustical Society of America, Cleveland, Ohio.

Oct. 26-28—Sixth Annual East Coast Conference, Institute of Radio Engineers' Professional Group for Aeronautical and Navigational Electronics, Lord Baltimore Hotel, Baltimore, Md. (Some classified sessions, sponsored by Air Research and Development Command.)

Oct. 26-30—National Conference, Society of Photographic Scientists & Engineers, Edgewater Beach Hotel, Chicago, Ill.

Oct. 28-29—Sixth Annual Computer Applications Symposium, Morrison Hotel, Chi-

(Continued on page 6)

AVIATION WEEK Including Space Technology

October 12, 1959

Vol. 71, No. 15

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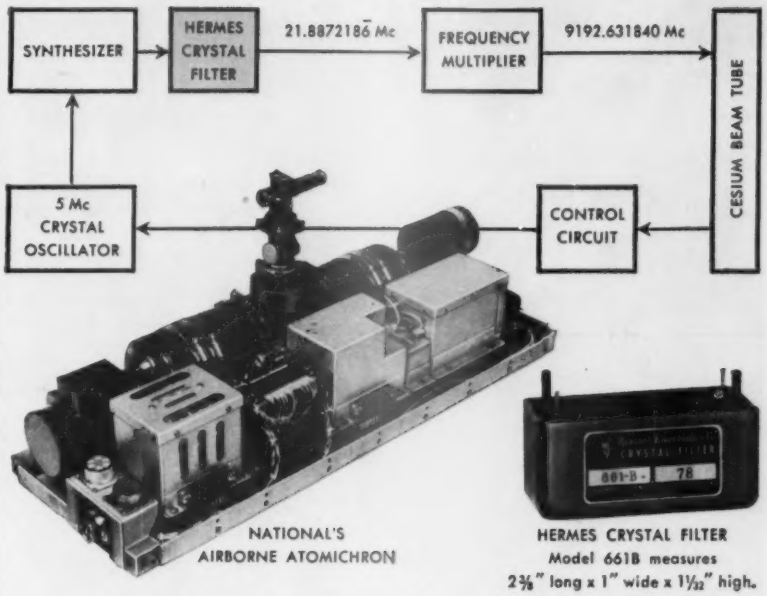
FIRST Airborne Atomic Frequency Standard Uses HERMES CRYSTAL FILTER



The National Company's Atomichron is the world's most accurate and stable instrument of its kind. It compares the precise unvarying resonance of the cesium atom which occurs at exactly 9192.631840 Mc with the ouput of a Crystal Oscillator. One of the critical problems in the development of the Atomichron was the elimination of spurious responses which occurred while generating the cesium frequency by a complex synthesis technique. The use of a Hermes Crystal Filter, Model 661B, between the Synthesizer and the Multiplier (see block diagram above) removed all spurious responses and allowed exactly 21.8872186 Mc to pass to the Multiplier.

Hermes Crystal Filters were selected for this critical application because of their sharp frequency characteristics, small size, and excellent performance over a wide range of severe environmental conditions. Close cooperation between the Engineering Departments of the two companies contributed to the rapid development of this new frequency standard. Hermes Crystal Filter's characteristics, Model 661B, include: Center Frequency: 21.8872186 Mc; Bandwidth at 6db: 6Kc; Bandwidth at 60db: 15 Kc; Insertion Loss: 3db max; Temperature Range: −55°C to +85°C.

Whether your selectivity problems are in transmission or reception, AM or FM, mobile or fixed equipment, you can call on Hermes engineering specialists to assist you in the design of your circuitry and in the selection of filter characteristics best suited to your needs. Write for Crystal Filter Bulletin.

A limited number of opportunities is available to experienced circuit designers. Send Résumé to Dr. D. I. Kosowsky.

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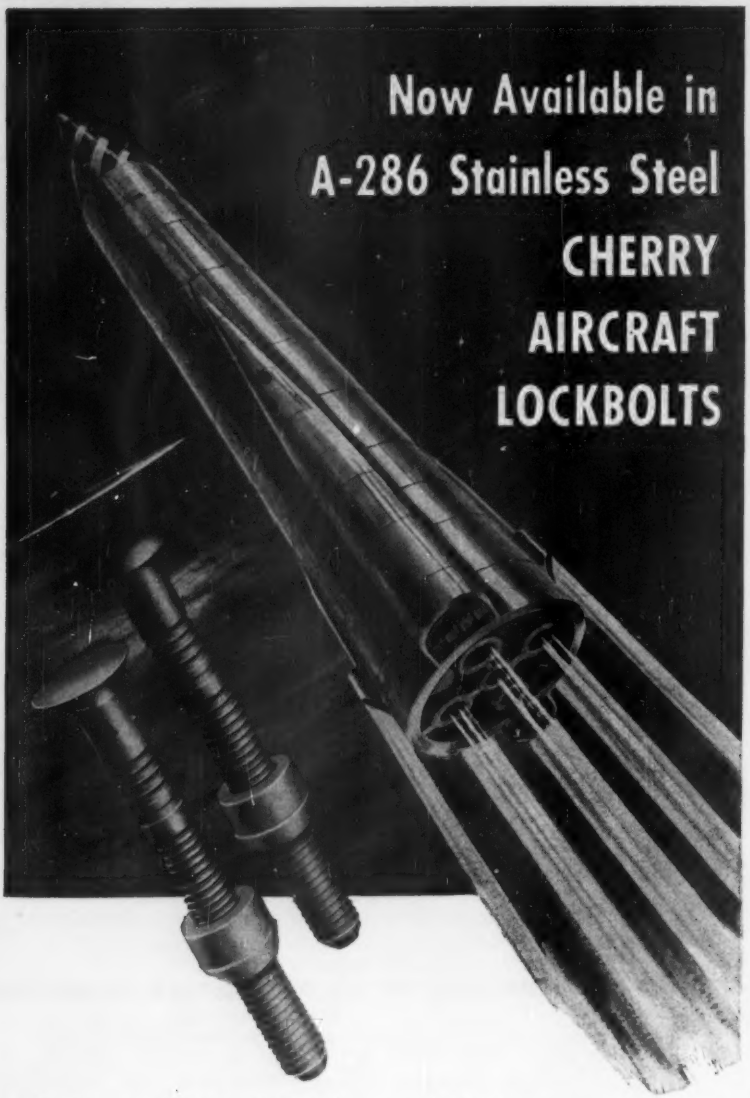

Designed especially for High Strength—High Temperature and liquid oxygen and other corrosive applications, Cherry Aircraft Lockbolts* are now available in austenitic A-286 Stainless Steel.

Available for the aircraft industry in a wide range of diameters, grip lengths and head styles in A-286 . . . Cherry Lockbolts are also produced in Alloy Steel and Aluminum.

Cherry Lockbolts are structural fasteners providing simplicity and speed of installation with uniform high tensile preloads.

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For information on Cherry Aircraft Lockbolts, write Townsend Company, Cherry Rivet Division, P. O. Box 2157-N, Santa Ana, California.

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AVIATION CALENDAR

(Continued from page 5)

cago, Ill. Sponsor: Armour Research Foundation of Illinois Institute of Technology.

Oct. 28-30—Annual Industry Display, Aircraft Electrical Society, Pan Pacific Auditorium, Los Angeles, Calif.

Oct. 29-30—Fifth Annual Electron Devices Meeting, Institute of Radio Engineers' Professional Group on Electron Devices, Shoreham Hotel, Washington, D. C.

Nov. 2-4—National Midwestern Meeting on New Frontiers in Aviation, Institute of the Aeronautical Sciences, Hotel Lassen, Wichita, Kan.

Nov. 2-5—Fall Meeting, Western States Section, Combustion Institute, Institute of the Aeronautical Sciences Bldg., Los Angeles, Calif. Subject: Equilibria and Performance of High Temperature Systems.

Nov. 3-5—11th Annual Mid-America Electronics Conference, Hotel Muehlebach, Kansas City, Mo. Sponsor: Institute of Radio Engineers' Kansas City Section.

Nov. 4-6—National Automatic Control Conference, Sheraton Hotel, Dallas, Tex. Sponsors: Institute of Radio Engineers; American Institute of Electrical Engineers; Instrument Society of America; American Society of Mechanical Engineers. AIEE is conducting a parallel Control System Components Conference on Nov. 5-6.

Nov. 9-11—Fourth Instrumentation Conference and Exhibit, Biltmore Hotel, Atlanta, Ga. Sponsors: Institute of Radio Engineers' Professional Group on Instrumentation and the Atlanta Section.

Nov. 9-20—13th Annual Air Transportation Institute, American University's School of Business Administration, Washington, D. C.

Nov. 11-13—16th National Meeting, Operations Research Society of America, Huntington-Sheraton Hotel, Pasadena, Calif.

Nov. 12-13—Quarterly Regional Meeting, Assn. of Local Transport Airlines, Marrott Hotel, Indianapolis, Ind.

Nov. 16-19—14th Annual Meeting and Astronautical Exposition, American Rocket Society, Sheraton-Park Hotel, Washington, D. C.

Nov. 16-20—20th Annual Convention, National Aviation Trades Assn., Hotel Montleone, New Orleans, La.

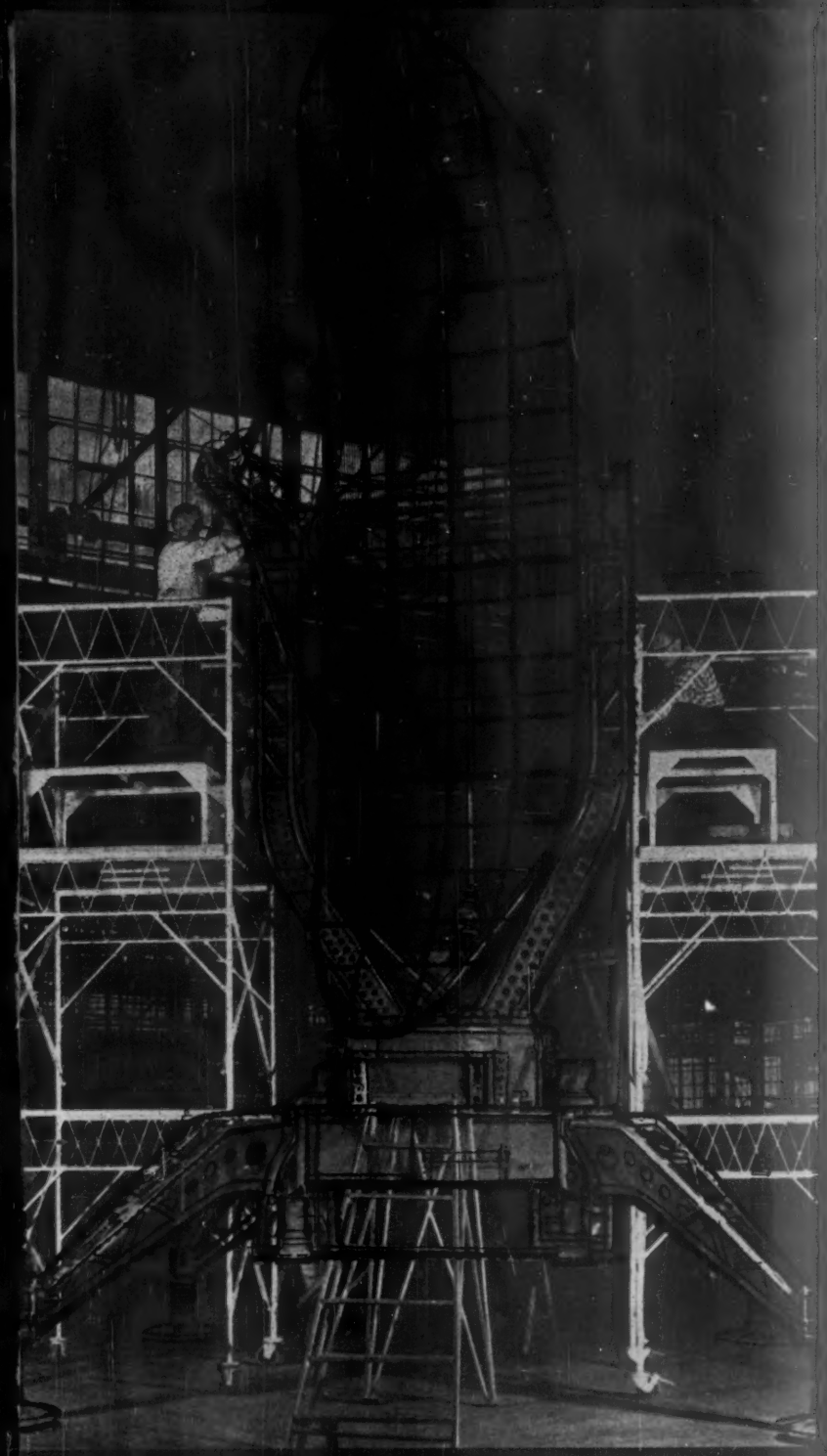
Nov. 17-18—National Turbine-Powered Air Transportation Meeting, Institute of the Aeronautical Sciences, Fairmont Hotel, San Francisco, Calif.

Nov. 17-19—34th Meeting, Aviation Distributors and Manufacturers Assn., Diplomat Hotel and Country Club, Hollywood, Fla.

Nov. 17-19—1959 Northeast Electronics Research and Engineering Meeting, Institute of Radio Engineers, Boston Commonwealth Armory, Boston, Mass.

Nov. 18—Fall Meeting, Eastern Division of Society of Aircraft Materials & Process Engineers, Sheraton-Carlton Hotel, Washington, D. C.

Nov. 19-20—Seventh Annual Aircraft and Missile Division Conference, American Society for Quality Control, Sheraton-Dallas Hotel, Dallas, Tex.



RADAR...
dishes and pedestals by Avco/Nashville

Today, radar takes many forms and handles many different tasks. Construction of a radar unit calls for several specialized design, engineering and production capabilities.

Such specialized capabilities are available at Avco's Nashville Division. At its large plant in Nashville, Tennessee, Avco/Nashville specializes in the design, engineering and construction of radar antennas or dishes. It also offers complete facilities for producing pedestals for large radars.

Recently the MPS-16 radar antennas and pedestals were manufactured by Avco/Nashville. Today, Avco/Nashville is at work on the antenna and pedestal of the FPS-26 radar, researched and developed by Avco's Crosley Division, that will stand three stories high and be housed in a radome about 50 feet in diameter. Also in production: very small radar antennas for use in the Mach 3 military aircraft that will be operating in the early 1960's. These use Avcomb, stainless-steel honeycomb.

Radar antennas of the conventional rod type, glass lay-up, and stainless-steel honeycomb are all within the proven capability of Avco/Nashville's engineering and production facilities.

Avco/Nashville has the capacity as well as the capability for more pedestal and antenna work, and invites inquiries from radar prime contractors. Write to: General Sales Manager, Nashville Division, Avco Corporation, Nashville, Tennessee.

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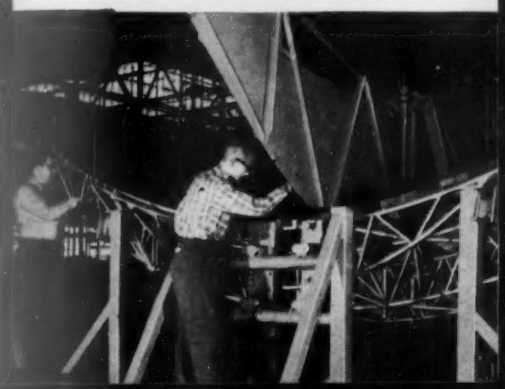

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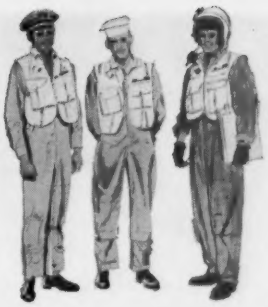
U. S. NAVY ELECTRONIC RECONNAISSANCE

The men:



A Navy electronic reconnaissance crew—operating from a fast carrier task force. Pilot, navigator and gunner are supplemented by four technicians operating highly accurate electronic equipment.

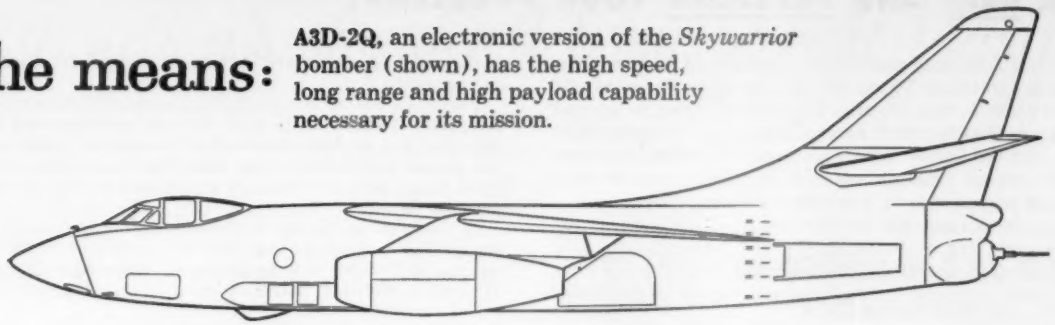
The mission:

Electronic reconnaissance. Navy crews will conduct electronic search scouting expeditions over troubled areas to provide information for other Navy aircraft and fleet operations. These might include missions by Douglas A3D-2P photographic aircraft or A3D-2 *Skywarrior* bombers.

OFFICIAL U. S. NAVY RECONNAISSANCE PHOTO

The means:

A3D-2Q, an electronic version of the *Skywarrior* bomber (shown), has the high speed, long range and high payload capability necessary for its mission.



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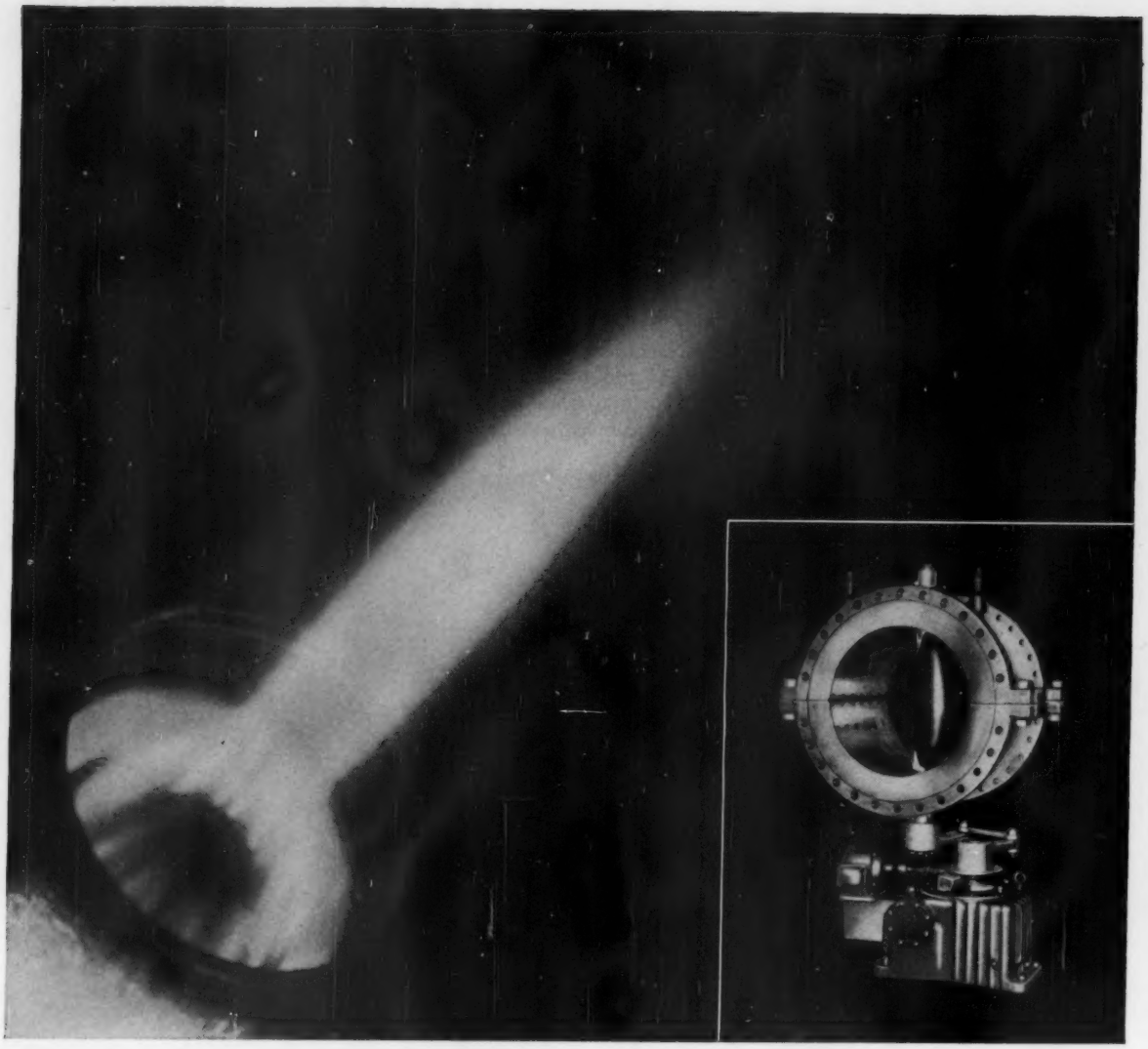

ARE HEAT AND PRESSURE YOUR PROBLEMS?

In a turbine exhaust test facility, 13-inch and 25-inch Allis-Chalmers Butterfly Valves like the one above (inset) handle gas at 2,000°F. and 180 psig. Carbon steel valve bodies and vanes are sheathed with Inconel. Each body is water jacketed, and the hollow vane, equipped with baffles, is water cooled through trunnion connections. Electric motor drive through a gear reducer provides rapid operation.

Unusual engineering is often required to relate all the factors involved in designing the best valve to solve fluid and gas control problems. If there is no precedence in your own past experience, Allis-Chalmers offers you a broad background of specialized valve engineering and manufacturing skills.

Perhaps a butterfly valve is the answer. It can be made of a number of materials to meet extreme working conditions, will give you uniform flow control through all positions in the normal regulating range. Simplified design and streamlined vanes reduce turbulence and pressure drop, help you save on power.

If you wish to find out more about how we can assist you in solving a fluid or gas control problem, contact your nearest A-C valve representative, or write Allis-Chalmers, Hydraulic Division, York, Penna.

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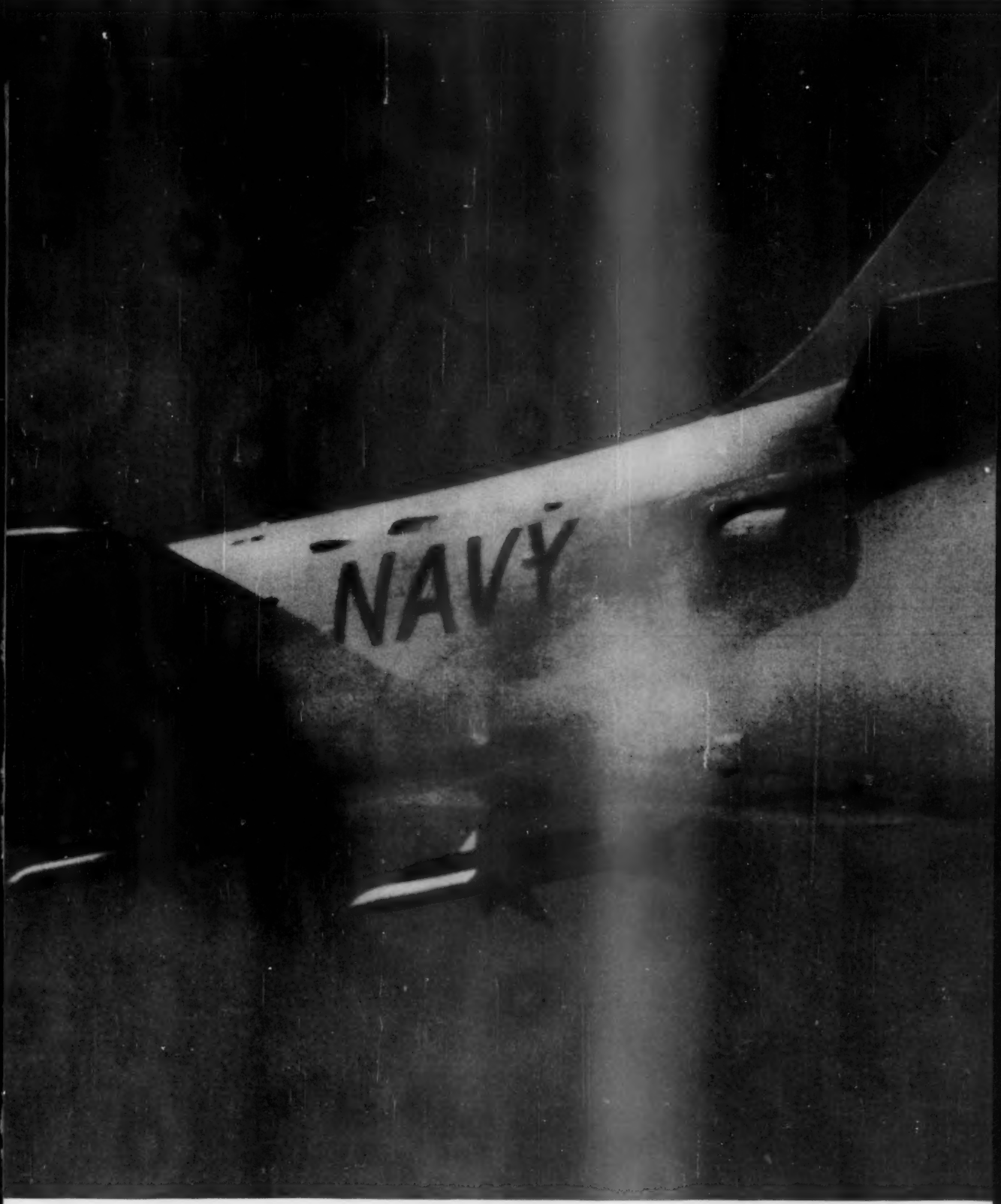

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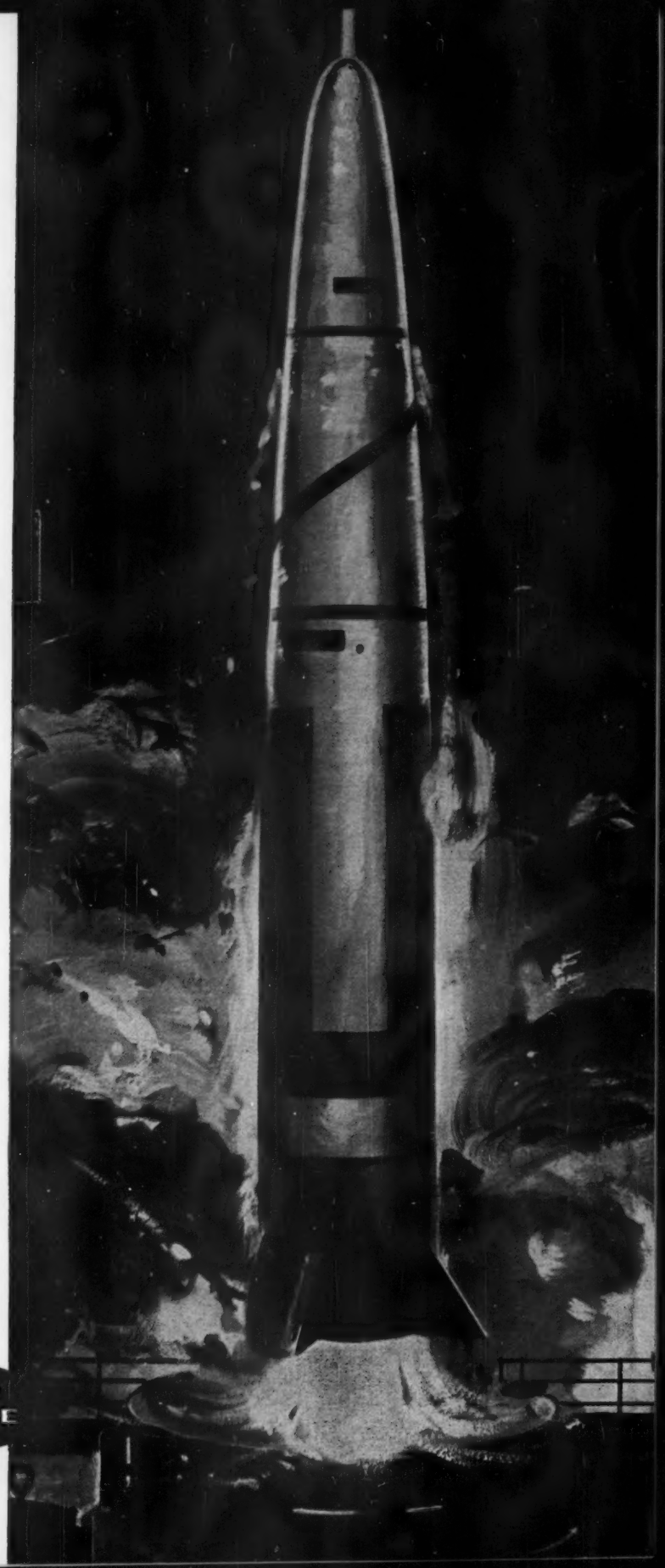

October 12, 1959

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Including Space Technology

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PICTURE CREDITS

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EXTENSIVE DOW PRODUCTION FACILITIES FASHION VARIED NEW MAGNESIUM WARES

Coiled sheet, thin wall castings, many other production items are now available from Dow's big rolling mill, foundry and fabrication facilities.

Manufacturers on the alert for improved materials and production methods would enjoy a quick tour of the four Dow plants that turn out magnesium products. New ways of forming and fabricating magnesium now being practiced in these plants open up new areas of use for the lightweight metal.

TOOLING PLATE, extra flat, is annealed to eliminate residual stresses.

At the huge Madison, Illinois, rolling mill, for example, they're making magnesium sheet that doesn't require stress relief after welding. This is a major step forward in light metal technology and a boon to manufacturers using magnesium assemblies. Madison has also increased the maximum width of sheet to six feet. Five different sheet alloys, including elevated temperature alloys, are now available either flat or in coils.

To keep abreast of the rapidly increasing demand for precision jigs and fixtures, Madison keeps a close watch on the tolerances of Dow magnesium tooling plate. Typical flatness tolerances, for example, are 0.010 inches in any six feet. This means greater accuracy and less machining for users of Dow tooling plate. A mammoth 13,200 ton extrusion press, also located at Madison, is now turning out magnesium extrusions up to 30-inch circumscribed circle in size.

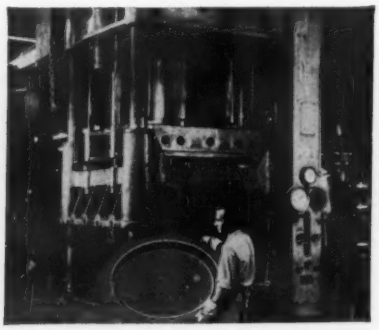
Over in Bay City, Michigan, interesting things are happening, too. At the well-equipped Dow magnesium foundry, largest in the U. S., sand and permanent mold castings of all sizes and shapes are being produced on a volume basis. Complete facilities are maintained for heat treatment, styrene DMI impregnation and chemical treatment. A well-staffed quality control team makes sure that all specifications are met or exceeded, and that the most modern equipment and techniques are fully utilized.

The Bay City foundry casts many complex and difficult designs. Large castings with walls as thin as 0.100 are now being produced. Other useful developments include cast-in tubeless passageways for use as hydraulic lines, special coring techniques for casting enclosed shapes and new magnesium casting alloys.

A new die casting plant is now on stream at Bay City. This facility houses the most advanced magnesium die casting equipment, including cold chamber metering units which automatically feed metal to the machines and contribute to unusually high production rates. To assure close alloy composition control in both die casting plant and foundry, a direct reading spectrometer provides frequent and precise analyses of the molten metal. Similarly, X-ray equipment is also available where radiography is needed in quality control.

The Dow fabrication plant, also in Bay City, offers capacity for volume work on magnesium assemblies. Here, too, developmental work on magnesium is constantly in progress. The plant is set up to handle large or small jobs, and plenty of both. Its activities include deep drawing, bending, spinning, stamping, piercing, machining, arc and spot welding, assembly, chemical treatment and painting. This plant has pioneered many "firsts" in magnesium production, such as hot drawing, spot welding and automatic welding.

DOW FOUNDRY offers production capacity for sand and permanent mold castings of all sizes.



LARGE DRAW PRESS at Dow's fabrication plant forms magnesium sheet in one operation.

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DOW

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EDITORIAL

IATA Faces Jet Hurdles

Climate of the IATA fare conference in Honolulu last week and the annual general meeting opening in Tokyo today indicates that the international airlines are facing realistically the problems of the jet age that are looming just ahead. Airlines that were sufficiently foresighted in equipment orders to enjoy the past six months of jet operations are in a rosy mood indeed. They are reaping a rich harvest from being the first to offer the tremendous speed advantages, plus some comfort advantages, of jet transportation.

Those less fortunate in their equipment programing can only stand by and await their turn, which will be coming next year at the latest. Problems faced by jet operators during the first relatively limited operations this year have been minor compared with those that are looming for next year and beyond. For the bulk of jet transport deliveries will be made during 1960, and by the end of next year the problems of full-scale jet operations, both technical and economic, will be pressing hard on airline managements.

Economic problems loom as particularly formidable, requiring both new imagination and vigor on the part of airlines sales organizations if any prospect for ultimate success is to appear certain. "Here lies the basic dilemma of the industry for years to come," Sir William Hildred, IATA director, told the opening session of the annual general meeting in Tokyo. "We need larger markets; in order to get them we must have lower fares. We are therefore buying new types of equipment which promise lower operating costs per seat mile. But we must at the same time take on much higher productivity. We know we can only get those lower operating costs if that capacity is fully utilized. This means we must get fares down still further. This is a full circle but not necessarily a vicious one. For with the price as a determining factor we all know traffic is ready and waiting."

Sir William predicted that by the time of the 1960 general meeting in Copenhagen a year hence, the jets would be producing more than half the airline industry's total payload capacity. "We shall have to feed progressively larger gobbets of traffic to those monsters or they will eat us up, capital and all."

Sir William also sounded a somber note on the current financial state of the international airline business, citing ICAO figures for all the world's airlines showing they operated during 1958 at an aggregate net operating loss of $160 million. This contrasted with an operating loss of $41 million for 1957.

If the capacious maws of jet transport cabins are to get the "progressively larger gobbets of traffic" that Sir William and everybody else in the airline business knows they are going to need for profitable operation, we suspect many airlines will have to forget the fact that they are in the airline business and begin operating as though they were in the travel business. This means the airlines must provide people with many more reasons to fly than now exist. Area vacation travel appears to provide an opportunity for getting a larger slice of an already rich melon. There is an urgent need to develop new areas for tourist travel to supplement well beaten paths to Europe and the Caribbean.

Even Europe may have trouble expanding the air travel market much farther without radical improvement in hotel capacity. The narrow, rapacious attitude of the French and British hotel keepers' guilds which have been extremely effective in throttling any significant expansion of tourist facilities in these key European gateways may prove to be the biggest factor in stopping a steady rise in U. S. travel to this area when jets provide a substantial capacity increase.

Even with the continued expansion of tourist travel to Europe and the Caribbean, new areas are needed for this type travel. The combination of jet speeds plus major fare reductions should make possible economical operation to more remote areas, such as the South Pacific islands, the Orient and Africa, to be brought into the vacation travel pattern. Already the first stirrings of this rising tourist boom in the Orient are evident where the recent prosperity of the Hawaiian Islands provides a case history of how air travel can create new tourist markets.

It would also appear high time for the airlines to take a good analytical look at their current credit practices from the viewpoint of potential customers rather than the airlines' own convenience. Current airline ventures in convenient credit such as the Air Travel Plan cards and "Fly Now, Pay Later" are pretty archaic in view of credit services now offered by many other major consumer businesses.

Pressure of the universal type travel credit cards now offered by a variety of hotel and travel organizations will inevitably force some constructive changes.

Technically, the superb performance capability offered by jet transports is already being inhibited by lack of proper airport facilities and anti-noise regulations. A jet cannot afford to operate at less than its full technical capability and still produce the operating economy promised by its manufacturers. Anti-noise regulation, despite the noisy bluster of the Port of New York Authority with its "subjective" decibel gaging, is a passing phenomenon that will disappear with the advent of turbofan engines if not sooner. However, the lack of runways capable of handling fully loaded jets for operations over optimum route patterns within the full range of local temperature variations is a problem likely to be with us for many years.

If concrete were being poured now for the jet runways required to develop fully jet route patterns it would be several years before these facilities would be available. But there is precious little evidence of any major concrete pouring.

When the main trunk routes become saturated with highly competitive jet service, as they will during the next year, operators will have a pressing requirement to operate them over a larger portion of their route patterns in order to get the high utilization rates and high load factors they seek. This is going to be a really tough nut to crack until a more vigorous campaign is conducted on improving airport facilities. The runway, however, is only one of the ground facilities that requires major improvements to handle jet traffic volume effectively. Passenger ticketing, baggage handling and checking-in procedures are far too cumbersome to service any quantity of one-hundred-seats-plus jet transports in anything close to economic turn-around time.

The air traffic control system will also begin to creak and groan more than ever next year under the impact of heavy jet operations. A single holiday weekend with bad weather under present traffic control procedures would be sufficient to force the jet fleet into providing a substantial quarterly deficit. Here there is no immediate relief in sight due to the long lead time on production and installation of airways and control equipment already ordered. We predict, however, the first few bad weather jet traffic jams will shake up parsimonious legislators who still at this late date delight in shaving significant percentages from the airways budget.

All these problems are certainly not insoluble and we have every reason to believe they will eventually be solved just as almost everything else has in the incredible history of powered flight. However, we suspect that the full impact of these problems of the jet transport era are not yet understood by many operators who may have been lulled into complacency by the fantastically profitable and relatively smooth technical operations of the first increment of jet transports to enter route patterns this year. To them we offer a word of warning—"Look out; its later than you think."

—Robert Hotz

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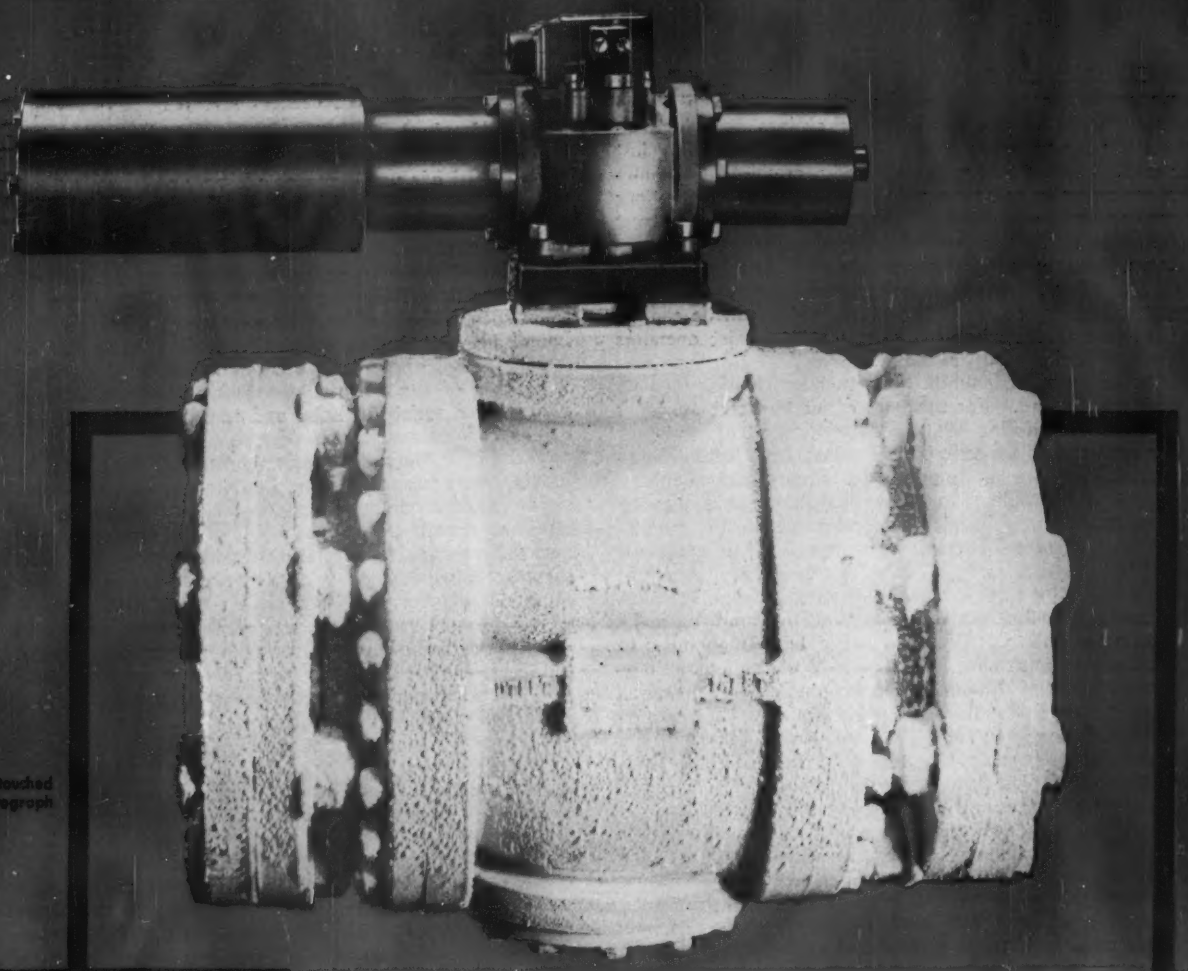

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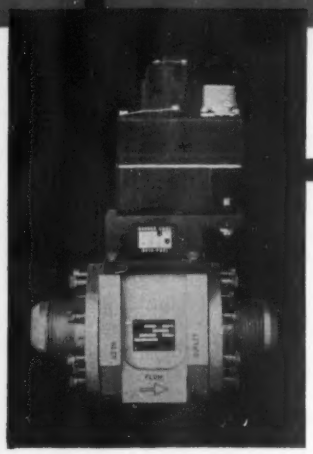

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Berne N. Fisher, vice president, Telecomputing Corp., Los Angeles, Calif. Mr. Fisher continues as general manager of Brubaker Electronics Division.

Henry Lehne, a senior vice president, Sylvania Electric Products, Inc., a subsidiary of General Telephone & Electronics Corp., New York, N. Y.

Thomas E. Holland, vice president, Beckman & Whitley, Inc., San Carlos, Calif., and director of the recently established Research & Development Division.

Frank P. DeLuca, Jr., executive vice president, Acoustica Associates, Inc., Plainview, N. Y. Also: **Fred C. Mehner**, general manager of the Western Division, Los Angeles.

Col. Robert H. Blount, commandant, USAF School of Aviation Medicine, Brooks AFB, Tex., replacing **Maj. Gen. Otis O. Benson, Jr.**, now commander of the new Aerospace Medical Center at Brooks AFB.

Brig. Gen. J. A. Barclay, acting deputy commanding general, Army Ordnance Missile Command, Redstone Arsenal, Ala. Gen. Barclay continues as commander of the Army Ballistic Missile Agency. Also: **Lt. Col. Nils M. Bengtson**, director of the Army Rocket and Guided Missile Agency's Ordnance Missile Laboratories Division.

Honors and Elections

Dr. James R. Killian, Jr., a director of International Business Machines Corp., New York, N. Y., succeeding Edward M. Douglas, resigned.

Mrs. Olive Ann Beech, president and board chairman of Beech Aircraft Corp., has been elected a director of Western Union Telegraph Co. succeeding Mrs. Madeleine Edison Sloane, the first woman board member of Western Union.

W. D. Dilworth and **Chester J. Jump**, co-chairmen of the newly formed Joint Committee for Air Express of the Air Transport Assn. of America, Washington, D. C. Mr. Dilworth is director-traffic administration and assistant secretary of United Air Lines, and Mr. Jump is vice president-administration and finance for the Railway Express Agency.

Changes

Dr. Benjamin P. Blasingame, director of engineering, AC Spark Plug Division of General Motors Corp., Milwaukee, Wis.

S. N. Lev, general manager, Missile and Surface Radar Division, Defense Electronic Products, Radio Corporation of America, Moorestown, N. J. The West Coast Missile and Surface Radar Department is now a division of RCA, and **Arthur N. Curtiss** has been appointed general manager.

John K. Records, manager of the newly formed Military Systems Section, General Electric's Defense Systems Department, Syracuse, N. Y.

INDUSTRY OBSERVER

► Initial version of a family of solid-propellant tactical missiles being proposed to Army by Chance Vought Aircraft, Inc., has a minimum range of 2,500 ft., a maximum range of over 20,000 ft. Proposed multistage follow-on versions of the missile would have ranges extending upward to 20 mi.-plus Five prototypes of the short-range version were fired earlier this year at Redstone Arsenal, with Army terming four of the launchings completely successful. The single-stage missile, developed with company funds from off-the-shelf components, is 12 ft. in length, weighs 522 lb. Missile is fired vertically from a portable A-frame launcher.

► **Delegation of high-level British aviation officials arrived in Washington last week for discussions with top U. S. government officials on long-range navigation aids. British will push for adoption of Dectra, an outgrowth of British short-range Decca navigation aid, which may lead discussion into the controversial subject of Vortac versus Decca for short-range navigation. British visit is follow-up to earlier visit to Britain by Federal Aviation Agency Administrator Elwood Quesada.**

► Radio Corp. of America will investigate basic radar techniques for discriminating between a ballistic missile nose cone and decoys under a million dollar contract to be announced shortly by Defense Department's Advanced Research Projects Agency. Program will be handled through Air Force's Rome Air Development Center.

► **Amphibious helicopter designed for rough water operating conditions up to Sea State 4 will be tested in full-scale YRON-1 rotorcycle configuration next year by the Gyrodyne Co. of America, Inc., St. James, N. Y., under Navy contract. Helicopter will be sustained on the water by four "tilt floats" that would line up horizontally during smooth water conditions. Under rough water conditions, the floats would be mechanically or hydraulically tilted to a vertical position, minimizing reaction of high sea states. Gyrodyne has successfully tested a one-fourth scale model in Great South Bay, N. Y., in waves corresponding in full scale to five feet in height. Hydrodynamic research testing was carried out under contract with Navy's BuAer.**

► Launch facility for Boeing's 400-mi.-range Bomarc B is now under construction at Vandenberg AFB, Calif. Funds for the $3.5 million facility are being supplied by the Air Force Air Defense Command, with contract administration under the supervision of the Army Corps of Engineers.

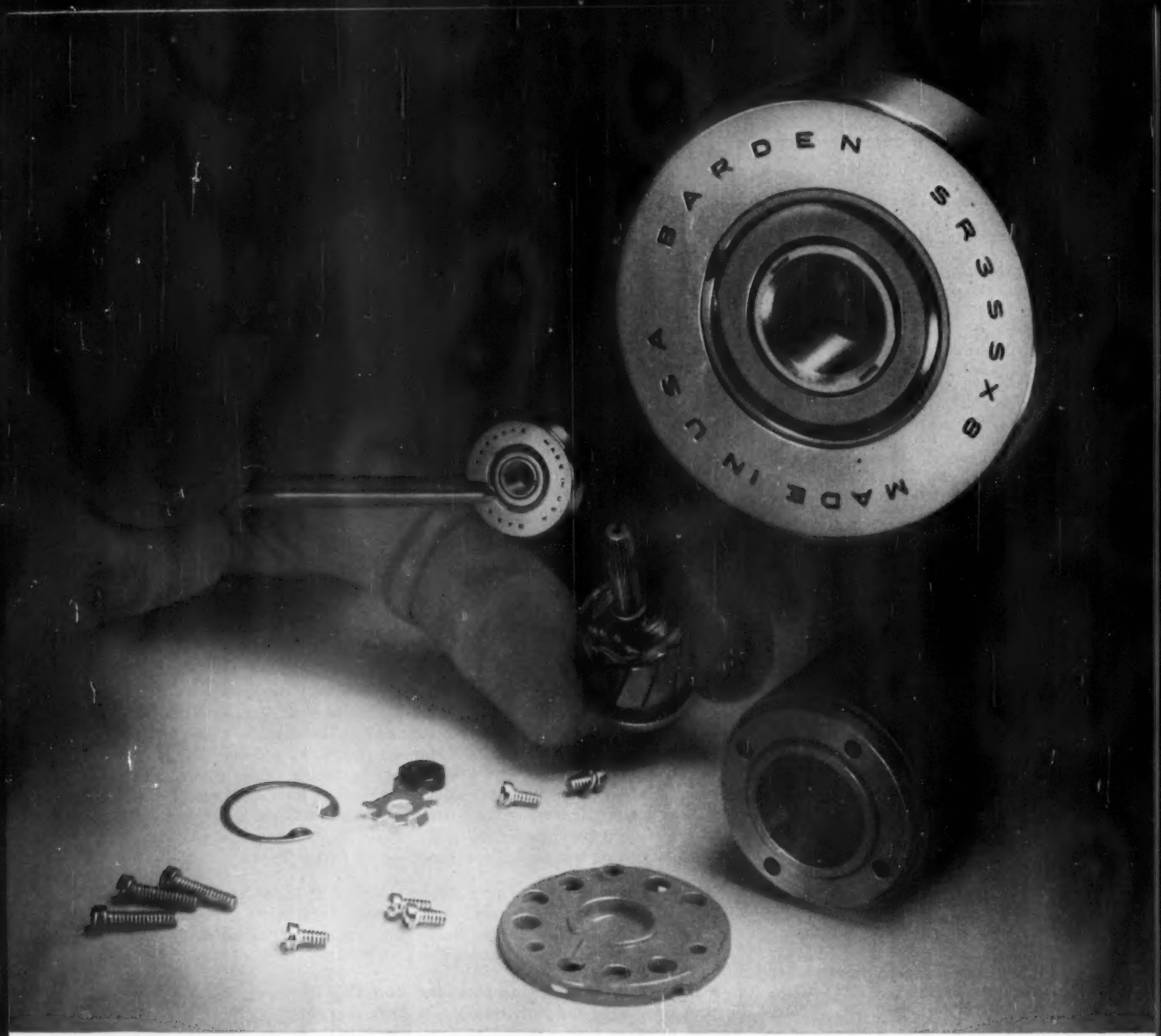
► **Industry's all-out engineer-scientist recruiting programs, which reached a peak this spring and early summer, is slackening off on the heels of cutbacks and program cancellations, such as the North American, under Defense Department's Fiscal 1960-61 budgetary squeeze. At least one very large avionics company is about to halt all recruiting programs.**

► Last of four Thor squadrons to be based in the United Kingdom is expected to be delivered by December. A fifth squadron is scheduled to be held in reserve status at Norton AFB, and its ground support equipment will probably be stored at Mira Loma, Calif. Thor production run will probably be stretched to March, 1961, to cover training vehicles and Advanced Research Projects Agency and NASA projects.

► **Jupiter intermediate range ballistic missile is being tested over ranges shorter than its 1,500-mi. standard range as a demonstration of the missile's flexibility. Recent test covered only a quarter of standard Jupiter range.**

► Business aircraft spokesmen expect total sales for the year to pass the 7,000 mark as compared with 6,414 in 1958 barring any cuts in production that might be forced on the industry by a prolonged steel strike. Deliveries for the first nine months of the year totaled 5,600 aircraft with a retail value of $128 million.

► **Total of $178,607,000 has been authorized thus far for construction projects at Vandenberg AFB, of which $83 million already has ben completed or programed. Fund breakdown includes $60 million for Atlas facilities, $43.3 million for Titan, $6.2 million and $19.8 million for space programs.**



Barden Precision SR3SSX8 bearings as used in a synchro transmitter/receiver.

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Washington Roundup

New Nuclear Plane Study

A unified aircraft nuclear propulsion program designed to satisfy Air Force, Navy and Defense Department has been set as the objective of a seven-man study committee recently formed by Dr. Herbert York, Defense Department director of research and engineering. Observers report that good progress is being made toward formation of a unified program for Atomic Energy Commission and Defense Department guidance as a result of present willingness of Air Force and Navy to compromise. Next meeting of the seven-man committee, which is scheduled to convene twice a month, will be held this week. Dr. Joseph Charyk, assistant Air Force secretary for research and engineering, is chairman. USAF Brig. Gen. Irving L. Branch is alternate chairman. Other members include Dr. Arthur Beal and John E. Jackson, of York's office; Joseph C. Jones, of USAF's ANP office; Rear Adm. Frederick Ashworth and Cmdr. Joseph F. Dorrington, Office of the Deputy Chief of Naval Operations for Development.

F4H Record Try

Navy plans to make a second attempt at recapturing the world's altitude record from the Soviet Union early next month with a McDonnell F4H all-weather fighter. In its initial try, the F4H exceeded the 94,661 ft. altitude reached by a Soviet single-engine turbojet-powered delta-wing fighter (AW Aug. 3, p. 32) but not by the 3% margin required by the Federation Aeronautique Internationale.

The Soviet record, recently certified by FAI, was established by an aircraft to which the Russians gave the unfamiliar designation T-431. It is believed to be a version of the Sukhoi delta fighters which made their first appearance at the Tushino air show in 1956. The initial Russian claim of 94,360 ft. was later boosted to 94,661 ft. by FAI after a study of the records and instruments involved.

Navy and McDonnell received Defense Department and FAI approval to try and exceed the record in early September (AW Sept. 7, p. 23) and under FAI regulations have until early December to make good. If the F4H fails, Air Force hopes to gain permission to make an altitude record attempt with a late model version of the Lockheed F-104. Before the Soviet flight, an earlier model of the F-104 held the record at 91,243 ft.

Air Guard, Reserve Reorganization?

Air Force, wary of the political implications involved but even more anxious to get the most from its tight Fiscal 1961 budget, may call for a broad reorganization of the Air National Guard and Reserve forces. The Guard alone now requires a quarter billion dollars of USAF support each year over and above the aircraft it has inherited from regular Air Force units.

First indication of the move came from Gen. Curtis E. LeMay, USAF vice chief of staff, who touched off a series of protestations when he termed the present reserve system of supporting both a National Guard and a Reserve force as separate units "inefficient and costly." Dudley C. Sharp, Air Force under secretary, planned to follow last week in a speech at the National Guard Assn. convention in San Antonio with a rundown on an air staff study now under way as to the future missions of the Reserves. Reaction to LeMay's statements, however, caused Sharp to retreat and call back the text of his speech which already had been distributed to the press.

While praising the work of the Reserve and Guard forces in the speech, Sharp said the traditional "backup" philosophy "that once applied to Guard and Reserve forces no longer holds true. There is no 'second team' as such. Active units, guards and reservists jointly form one first string deterrent force now. And if war is forced upon us, all become one combat team."

Sharp intimated that the Guard of the future might be asked to place more emphasis on ground support duties, less on actual flying. As to missiles, the speech said "we do not have a positive and final answer on the question of how the Guard fits into the picture. But I am of the opinion that we should use it to whatever extent is possible."

Manpower Cuts

In another move to fit within the Administration-imposed Fiscal 1961 budget structures, both Air Force and Navy probably will make limited manpower cuts within the near future in order to put more of their allotted funds into procurements. Assistant Secretary of Defense Charles C. Finucane says USAF and Navy are volunteering the cuts which involve approximately 5,000 men in each service. Defense Department, Finucane said, neither directed nor suggested the personnel cuts.

USAF: Modesty Defined

Air Force has worn its best diplomatic face thus far in discussing the delicate—from the Pentagon politics point of view—question of whether it is becoming the U. S. space force now that it has been told to develop all space boosters (AW Sept. 28, p. 27). It has tried publicly to discourage any such impression and to emphasize the idea of cooperation with the other services.

In the privacy of its own home, however, it wears another face. The headline and first paragraph of Release No. 1831 prepared by the Internal Information Division of USAF's Office of Information Services, reads:

"USAF to Be Aerospace Force, Department of Defense Says.

"In language calculated to dispel any lingering traces of doubt, the Department of Defense recently (Sept. 23) tapped the Air Force to be America's primary service in space as it now is in the earth's atmosphere."

Navy Reunion

Navy staged a Washington reunion for its former civilian chiefs last week in an effort to bring them up to date on the service's fiscal, hardware and mission requirements. Fourteen former secretaries, under secretaries and assistant secretaries were invited to the briefing sessions and receptions given by Navy Secretary William Franke, Under Secretary Fred Bantz and Assistant Secretaries Richard Jackson, Cecil P. Milne, and James Wakelin. Reunion guests were Mark Andrews, David Ingalls, Sinclair Armstrong, Herbert Askins, Garrison Norton, James Hopkins Smith, Charles Thomas, Dan Kimball, John L. Sullivan, Albert Pratt, Ernest Lee Jahncke, John Koehler, Raymond Folger and Thomas Gates, former Navy Secretary and now Deputy Secretary of Defense.

—Washington staff

U.S. Plans Gyro-Stabilized Solar Satellite

NASA also schedules magnetic field lunar probe, ionosphere satellite, paddlewheel probe within year.

By Michael Yaffee

New York—Gyro-stabilized solar observatory will be one of the sophisticated, second generation, scientific satellites and space probes which the United States hopes to launch within the next year.

Others will be an ionosphere satellite, a magnetic field lunar probe and a paddlewheel deep space probe, John W. Townsend, Jr., assistant director of National Aeronautics and Space Administration's Goddard Space Flight Center, told the Seventh Anglo-American Aeronautical Conference of the Royal Aeronautical Society and the Institute of the Aeronautical Sciences.

Present plans call for a launching approximately every two months but NASA may be able to increase the frequency of its space shots later on in the program.

NASA's gyro-stabilized solar satellite, which is presently in the design stage, will be placed in a circular orbit underneath the Van Allen radiation belts. The orbit will be planned so as to keep the satellite in sunlight all the time.

Townsend said five units constituted a long production run in space vehicles. Standard practice is to take the first two or three of the vehicles, call them prototypes and test them under far more severe conditions than the remaining units, the flight vehicles, are expected to encounter. In the case of the solar satellite there will be more than five vehicles produced, according to Townsend.

The first solar satellite is expected to weigh approximately 350 lb. Later ones may weigh as much as 500 lb. As now estimated, they will measure 36 in. in diameter and will be launched by Thor Delta rockets. Designed primarily to provide more descriptive information about the sun, each satellite will carry a spectrometer to measure solar radiations.

First solar satellites will be designed to pick up ultraviolet radiation and X-rays. Later, visible and infrared observations will be added. Eventually, provisions for picking up radio noise from the sun may be included.

Base of the solar satellite will be a thick disk, hollowed out to save weight, approximately 36 in. across. To spin-stabilize the base, there will be two small cold gas jets attached diametrically opposite each other to the rim of the disk that will spin the base at the rate of one revolution per second.

Rising approximately 15 in. from the center of the base will be the column holding the spectrometer. On top of this column will be the precession rockets.

A helium tank contained in the base will provide the propellant for both the precession and spin rockets.

Attached to opposite sides of the column will be two banks of photo cells. Mostly these will be solar cells which will provide the power for moving the spectrometer and communications. But interspersed among these will be the sun-seeking eyes which will keep the spectrometer aimed at the sun. The spectrometer will be essentially a rectangular unit about 20 in. long, 8 in. high and 3 in. wide. It will project through the center column and will be able to move up and down as well as right and left.

Out of the estimated 350 lb. total weight of the initial solar satellites, it is calculated that the spectrometer, pointing system and structure will weigh only about 150 lb. This will leave another 150 to 200 lb. that NASA scientists plan to use to fly 10 to 12 additional experiments in cooperation with several universities. These will be mounted inside the satellite's flywheel base and will essentially be photometric measurements that don't require accurate or constant orientation to the sun.

With the exception of the pointing mechanism, NASA scientists plan to have a complete backup unit for every system in the solar satellite to ensure the success of the experiments in the event of component failure. Among others, for example, there will be two telemetry systems and two command systems.

The magnetic field lunar probe which NASA hopes to launch within the next year will have what Townsend describes as a fantastically accurate light pumping magnetometer for measuring the magnetic field on the moon and between earth and moon. Working fluid of the magnetometer will be rubidium 85. In essence, the magnetometer will work by measuring a characteristic of the rubidium 85 which is dependent solely on the magnetic field the rubidium 85 is in.

The magnetic field lunar probe is expected to measure about 30 in. in diameter and weigh somewhat under 100 lb. A Thor Delta rocket will probably be used as the booster. A big bank of chemical batteries will provide the relatively large amount of power required by the magnetometer.

Soviets Lead in Space Booster Size

Russia is definitely ahead of the United States in the size of its space booster vehicles. While this is apparent, says NASA's John W. Townsend, Jr., it is also the only sure conclusion to draw regarding Soviet space work vis-a-vis that of the United States.

Townsend, who visited Russia recently and talked directly to scientists involved in the Soviet space program, also tends to believe that their boosters are more reliable than ours and that the Russians, as they say, have had few failures.

On the other hand, says Townsend, re-entry technology is more advanced in this country. The United States has better ablating materials and the work here on beryllium-copper heat sink systems is ahead of that in Russia.

The United States is also ahead of Russia in instrumentation, Townsend believes. Soviet instruments are less sophisticated and may account in part for the large size of their satellites and space probes. The Russians do have some good electronic equipment but apparently not enough to go around. In Sputnik III, for example, there were some excellent transistors but mixed in with these were a number of conventional, full-size electron tubes.

Unquestionably and, perhaps, unfortunately, says Townsend, the Russians are doing good, sound, scientific space research. With the exception of the small Soviet pennants on their lunar impact rocket, Russian scientists are little concerned with propaganda considerations.

On the whole, Townsend feels, the Russians are more purposeful than we are. They select a few things they want to do and then go after these objectives. The reason the Russians haven't launched any satellites since Sputnik III, for example, is that their space scientists have been concentrating on lunar probes.

Another reason for the Russian space successes is that Soviet enthusiasm—both official and public—has not waned as it has in this country, he said.

NASA SOLAR SATELLITE will be spin-stabilized by two cold gas jets attached to rim of the base. Spectrometer protruding through center column will be aimed at the sun by "eyes" located in flanking banks of solar cells which will provide the auxiliary power.

To make sure there are no stray magnetic fields present that can throw off the magnetometer, Young Development Division of Hercules Powder Co. is making the shells for the magnetic field lunar probe out of glass fiber-reinforced epoxy plastics like those used in the shell of the Vanguard III satellite. As an additional precaution, wires from the chemical batteries in the probe will be wound so as to cancel out their magnetic fields.

A listener from Sperry Gyroscope told Townsend that his group at Sperry, also very much interested in guarding against the presence of stray magnetic fields, had been very surprised to discover that plastics could create a magnetic field. Townsend replied that the shells for the magnetic field lunar probe were carefully checked to make sure that they were free of any magnetism, and he pointed out that in the fabrication of these shells, it is specified that the glass reinforcement mat is not to be drawn through a steel die owing to the danger of picking up steel chips.

Sometime next year, NASA expects to launch two ionosphere satellites. These will weigh approximately 100 lb. each and will be about one meter in diameter. Chemical batteries will supply the auxiliary power required. Launching vehicles will be Juno IIs which will be aimed to place the satellites in orbits ranging from 135 mi. to 800 mi. above the earth at a 50-deg. inclination.

Juno II will also be used soon, said Townsend, in an attempt to put another "Heavy IGY" satellite into orbit. Original attempt at orbiting this satellite failed last July when the booster vehicle had to be destroyed shortly after liftoff (AW July 27, p. 39). Instrument package of the new satellite like that of the original (AW Aug. 3, p. 61) is designed to carry out several experiments in a clean up of unfulfilled IGY objectives.

NASA also plans to launch several more paddlewheel vehicles similar to the Explorer VI satellite now in orbit (AW Aug. 17, p. 30). One of these, which may be launched before the end of the year, will be a deep space probe. It will be fired toward the sun and is expected to go into an orbit that will intersect the orbit of the planet Venus and that will be somewhat closer to the sun than that of Venus. A Thor Able rocket will serve as the booster vehicle for the paddlewheel probe.

One of the most interesting and significant aspects of this probe is that it will carry equipment that may enable scientists for the first time to communicate over a distance of 50 million miles. NASA scientists believe they will be able to communicate with the probe over a distance of 20 million miles.

Asked about the significance of Russia's lunar impact rocket, Townsend said that the discovery of an ionosphere above the moon was more significant and surprising to him than the apparent absence of a magnetic field. The detection of an ionosphere at a relatively high distance above the moon, he said, means that the moon has a definite atmosphere, a condition that a few scientists could only guess at before.

On the other hand, the fact that the Soviet magnetometer, which had a sensitivity down to only 100 gammas, found no magnetic field at its cut-off height of 50 mi. or so indicates only that the moon has no strong magnetic field. Even before the Russians impacted a rocket on the moon, Townsend said, scientists in his group believed that a lunar magnetometer would have to have a sensitivity below 10 gammas and possibly down to one gamma to detect any magnetic field of the moon.

De Havilland Wins Award

De Havilland Aircraft Co. received the Elmer A. Sperry Award for 1959 for its "successful development of the world's first jet-powered airliner," the de Havilland Comet.

The award specifically cited Sir Geoffrey de Havilland, president of the company, Charles C. Walker, technical director and chief engineer during the development of the Comet, and the late Maj. Frank B. Halford, former chairman and technical director of de Havilland Engine Co.

Presentation of the award was made at the conference dinner of the Seventh Anglo-American Aeronautical Conference of the Royal Aeronautical Society and the Institute of the Aeronautical Sciences.

Soviets Plan Series of Lunar Vehicles

By Evert Clark

Washington—Lunar probe launched by the Soviet Union on the second anniversary of Sputnik I was the third in a planned series of vehicles that apparently will explore the neighborhood of the moon before either planetary probes or manned orbital flights are attempted.

Probable lunar missions discussed by Soviet scientists since a Russian payload struck the moon last month include large stabilized moon-circling satellites and continuously-transmitting instrument stations placed on the lunar surface in the way that automatic weather observation stations are dropped on Arctic ice floes.

Russia's third lunar probe was launched early in the morning of Oct. 4, Moscow time. It passed the moon at a distance of about 4,350 mi.—closer than the original forecast of some 6,214 mi.—two and a half days later (10:16 a.m. EDT Oct. 6). The probe continued to travel outward from the earth toward an expected maximum distance of 292,043 mi. Soviet announcements said it would reach this apogee of its highly elliptical orbit on Oct. 10 and then begin a return journey toward earth, passing within 24,855 mi. of earth on Oct. 18. Earlier estimates had been that the probe would pass within 1,250 mi. of the earth.

The fact that this translunar satellite was launched only three weeks after the Soviet rocket that placed a payload on the moon was not surprising. Premier Nikita Khrushchev said on his recent visit to the U.S. that another lunar rocket—the one originally intended for the impact shot—was "still in its place" and "if needed we might launch it later on" (AW Sept. 28, p. 28).

Official Announcements

Official announcements up to one day after the probe made its closest approach had made no mention of photographing the heretofore unseen side of the moon, although that ordinarily would have been a major scientific objective of such a shot. Georgi Duboshin, head of the celestial mechanics department of Moscow's Sternberg Astronomical Institute, was quoted as saying he believed the lunar probe was prepared to make pictures of the moon's far side similar to the photographs made by a recent American satellite. This apparently was a reference to the crude image transmitted by Explorer VI of a portion of the earth (AW Oct. 5, p. 29).

First indication from the Russians as to the makeup of the rocket was contained in a broadcast that Academician Leonid Sedov made on Moscow Radio's home service on the day of the launching. Sedov spoke of giving a somewhat lower initial speed to "the third stage" of the latest rocket than that given to "the last stage of the second cosmic rocket launched on Sept. 12. . . ."

Although the initial announcement said that one radio frequency would be used to control "the elements of the orbit," no official reference was made to the use of retrorockets or other devices to control the probe's velocity vector while it was in the moon's vicinity or to affect its apogee. The fact that it was to pass some 56,000 mi. beyond the moon indicated to some U. S. observers that no orbit control device was used.

But A. A. Shternfeld, holder of the Tsiolkovskii international prize for encouragement of astronautics, wrote in one Soviet newspaper: "We hope in time it will be possible to regulate its orbit so that the station periodically will arrive over the unseen side of the moon."

At one point Shternfeld estimated that the apogee would be about 259,000 mi. from earth, that the period would be about 10 days, 22 hr. and 49 min., and that after five orbits, taking 54 days, 15 hr., 26 min., the station would again come into the vicinity of the moon. He said his computations were theoretical since they did not account for the influence of the moon's attraction.

In contrast to the policy it has followed on earlier space flights, the Soviet government did not announce details of the instrumentation aboard the 614.09 lb. payload package.

In addition, the last stage of the Soviet rocket carried "measuring apparatus with a power supply of 345.08 lb.," according to Russian announcements. Stage weighed 3,424.37 lb. without fuel, but it was not clear whether that included the 345 lb. of instruments.

The probe, referred to by the Russians as an "automatic interplanetary station," separated from the final stage. It carried both solar batteries and "chemical sources of current." Its transmitters were used only during two to four hour periods each day. Data obtained by the instruments presumably was stored for quick transmission. Transmitters were turned on by interrogation from ground stations rather than from a timer in the probe.

Scientific measurements and trajectory information were broadcast by two transmitters on 39.986 mc. in pulses of varying in duration from 0.2 to 0.8 sec., and on 183.6 mc. The higher frequency also was to allow control of elements of the orbit.

Transmitters were on at the time of passage near the moon, and Soviet announcements said signals indicated all instruments were working properly. At 1 p.m. EDT on Oct. 6, about two and three-quarter hours after its nearest passage the probe was 9,321 mi. from the moon and was near the plane of the moon's equator with a lunar longitude of 137 deg. and a lunar latitude of 12 deg.

U.S. observers had calculated that the probe would cross the moon's orbit ahead of the moon—an unfavorable position for observing its unknown side—but an unofficial diagram appearing in Moscow newspapers on Oct. 6 showed the probe crossing the moon's track just after the moon had passed the point of crossing.

Jodrell Tracking

A British team assisted by a Space Technology Laboratories team tracked the probe on either one or both frequencies each day from launching through the nearest passage, using the University of Manchester's 250-ft. diameter Jodrell Bank radio telescope. Russians cabled accurate space and time coordinates to the Jodrell scientists prior to each daily transmission.

On the first day, Jodrell received signals on both frequencies at approximately half-second intervals, for about 20 min. up to the end of the transmission period. On the second day, Jodrell tracked for a full two hours. On the third day, when the probe neared the moon, strong signals were received on 183.6 mc. two minutes before the scheduled transmission time. They were characterized by a sequence not previously used. It consisted of 15-sec. signals spaced 14 to 15 sec. apart. Nothing was received on the lower frequency.

After 20 min., the transmission changed to irregular sequences on two very closely spaced frequencies and continued for a little more than half an hour. Remainder of the transmission that day was a steady signal which ended sharply an hour and 38 min. after the first signal had been received. There was one four-minute silence 13 min. after the transmissions had begun, leading to some speculation that a partial eclipse of the signals by the moon had occurred since this was the only break during any day's transmissions.

Throughout this day's tracking, the telescope was closely aligned with the direction of the moon. No recognizable doppler shift had been recorded.

On the day after it crossed the moon's orbit, the probe was again

tracked by Jodrell for at least one hour and 10 min. It repeated the character of the previous day's transmission.

Dr. J. G. Davies, head of the Jodrell group, told AVIATION WEEK that analysis of the tracking data obtained from the previous Soviet moon probe confirmed that it impacted near the center of the moon's disk in the region where the Russians said it landed. Davies said total doppler shift recorded in the last hour of the probe's flight was 300 cycles. Plotted against time, this gave a smooth frequency/time curve completely consistent with the theoretical acceleration and velocity values that would be exhibited by a freely falling body on the moon's surface. There was a 50% increase in velocity over the last hour of flight and a terminal velocity of 1.86 mi./sec.

Dr. Richard C. Booton, manager of STL's guidance and navigation department in California, said computations made there on the basis of Soviet announcements and the Jodrell tracking indicated that the total time of the probe's orbit around the earth would be nine to 12 days. Time spent beyond the moon's track was expected to be four to seven days, and apogee about 80,000 mi. past the lunar orbit. These calculations also indicated the probe passed slightly in front of the moon as the moon moved along its own orbit and slightly below the plane of the moon's orbit. Indications were that the probe might have a perigee as close to the earth as 5,000 mi.

Eventually, Booton said, the probe may be drawn into the moon or into the earth's atmosprere. Except for perturbations caused by the moon's attraction, it would have infinite life.

Modulation of the frequency as the probe passed closest to the moon changed a number of times to a much higher modulation, indicating that many experiments were being conducted and that the Russians were trying to crowd into a short time period more information than they wanted from other portions of the trajectory, according to Booton.

There are some indications that the Soviets may soon try to place a transmitting observatory on the moon, although they concede that the problem of managing a soft landing still exists.

Four days after the impact shot, Prof. Vladimir Dobronravov gave what apparently was a hint of the most recent probe when he said the area of the moon also could be studied with rockets that would not impact. Tass quoted him as saying that "even now it would be most interesting to send a rocket around the moon to obtain information about the physics of the moon and its surrounding area. The fact that Soviet technology is able to create guided space vehicles may have other far-reaching consequences. It is quite possible to develop guided and recoverable Sputniks."

Shternfeld said just after the impact shot that "exploration of the moon will continue . . . just as artificial satellites took off into the sky one after another." Most of his article in Komsomolskaya Pravda was a technical discussion of lunar orbiters.

A few days later, Boris V. Kukarkin, deputy chairman of the USSR Academy of Sciences' astronomical council, said "the time is probably not too far distant when it will be possible to put continuously-operating automatic devices on the moon's surface. These devices will make observations of the sun and transmit the information to the earth. . . .

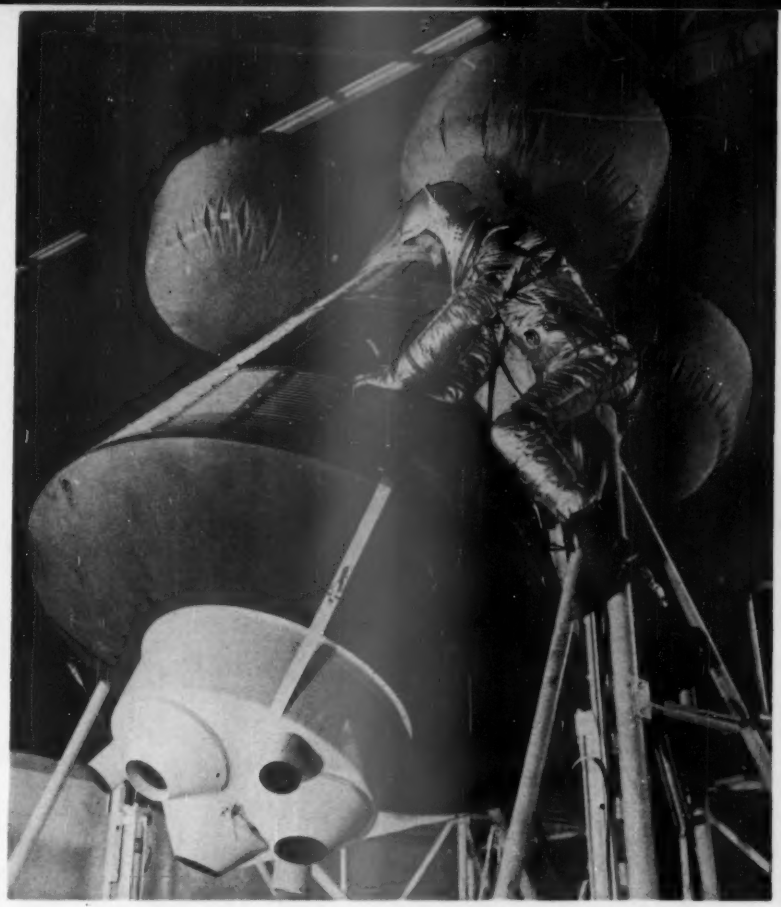
"There is every basis to suppose that the time is not too distant when automatic installations on the moon's surface or on a heavy, stabilized satellite will provide the opportunity to search for weak, non-stationary stars . . . and to conduct systematic investigations of them by the most modern methods."

Kukarkin said these devices probably will preceed manned flight to other planets because man's life must be guaranteed and "here, many difficulties must be overcome." He also said special braking devices must be developed for letting a lunar observatory down to the surface slowly "but this is an engineering problem and we know that engineering tasks considerably more complicated than this are now being solved successfully."

Victor Bazykin, director of the Moscow Planetarium, recently wrote that before long an automatic cosmic station of the kind which are parachuted into various Arctic areas will be dispatched to the moon.

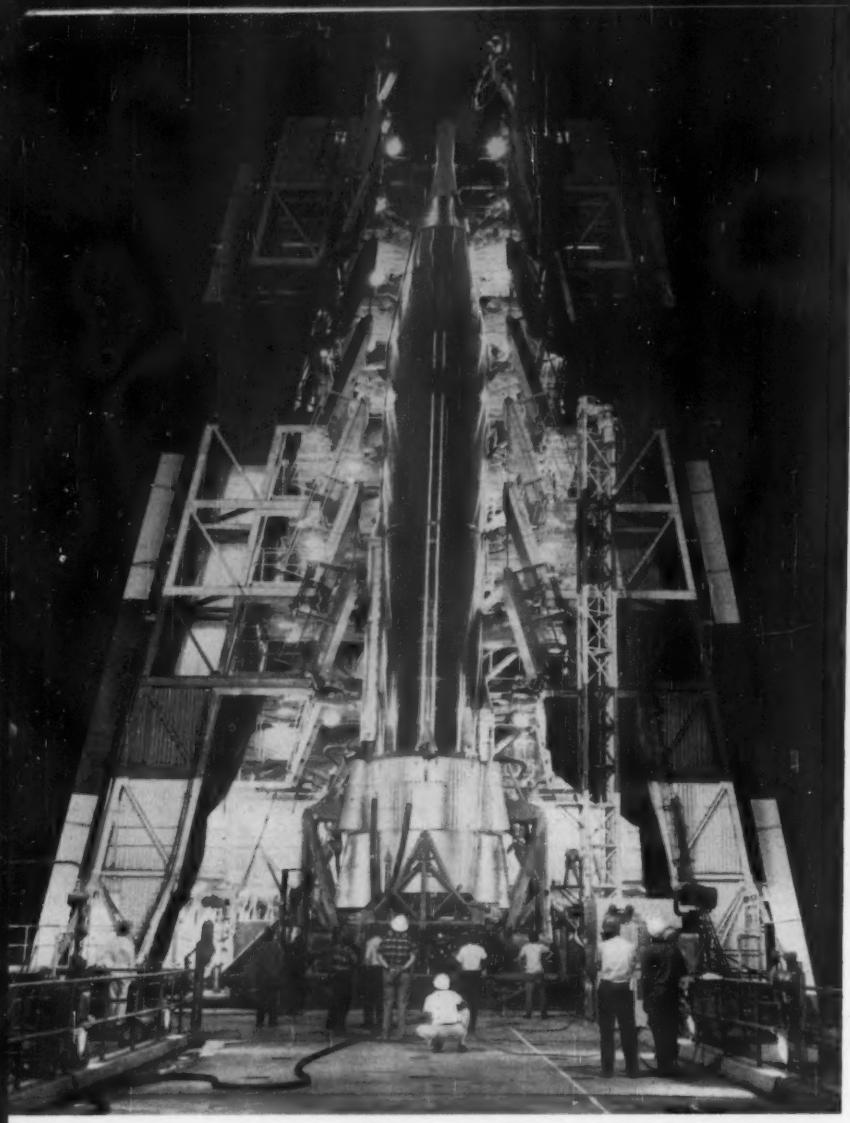
Academician V. A. Kotelnikov wrote in Izvestia that "the problem of landing apparatus safely on the moon has not yet been solved" and "much more will have to be done in the near future."

Prof. Dobronravov wrote just after the lunar impact shot that "probably there will be a series of further flights . . . for investigating the space around the moon" as the next steps in space research. Later will come "guided earth satellites of the earth or even of the moon."

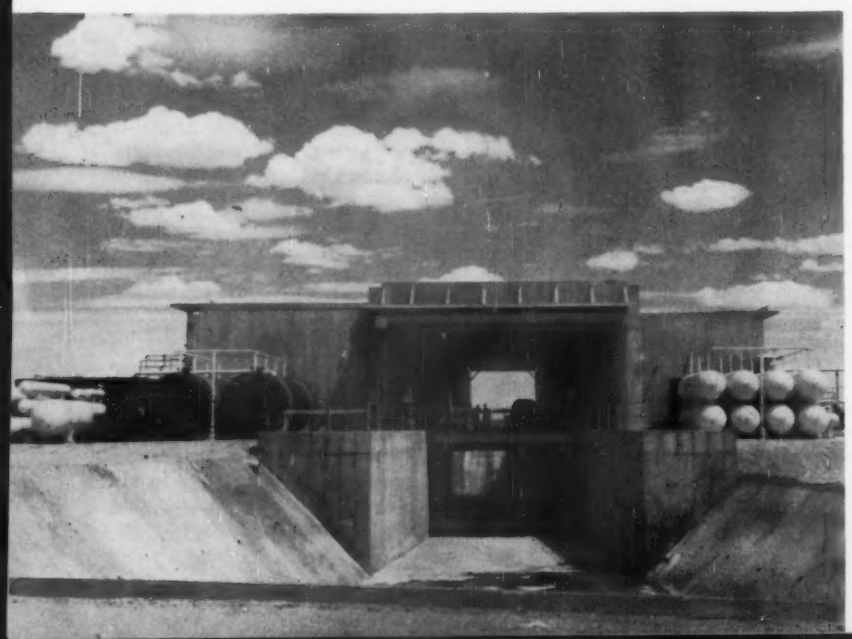


Mercury Mockup Shows Shingle Skin

Stainless steel alloy shingle structure on McDonnell Aircraft Corp.'s Mercury capsule mockup is designed to take heat expansion without stressing the capsule outer skin. Cone shaped nozzles are re-entry rockets; cylindrical nozzles are posigrade rockets used to separate the capsule from its Atlas booster. Flotation bags (top) are carried in "tail" cannister.



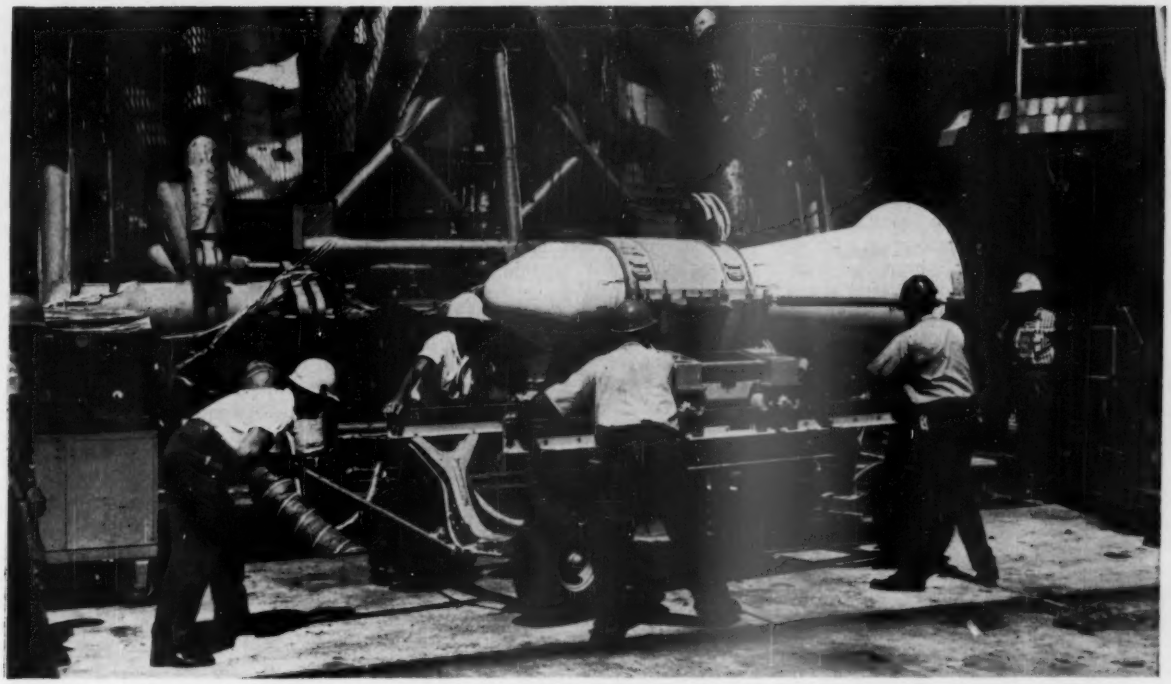
USAF-Convair Atlas 18-D missile, in gantry at Pad 11 at Cape Canaveral, Fla., carried first General Electric Mark 3 ablation re-entry vehicle over 5,000-mi. range last week. Cone will be used on second group of Atlases. Below, first Atlas pad at Warren AFB, Wyo.



Mark 3 nose cone, 10 ft. long is readied for first flight on Atlas ICBM.

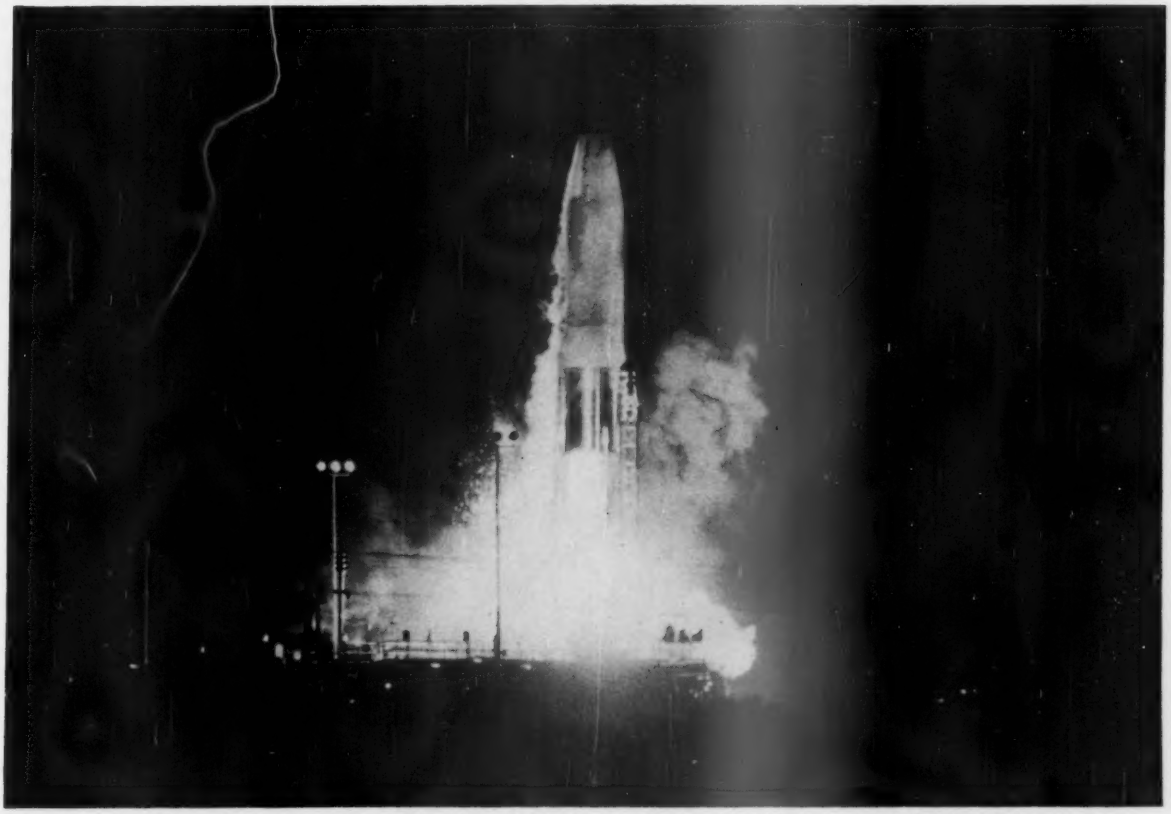
New Ablating

First General Electric Mark 3 ablating nose cone for operational USAF-Convair Atlas intercontinental missile was successfully flown over full range at Air Force Missile Test Center last week on Atlas 18-D. Although operational version will look like this, series of Mark 3s will be flown before vehicle reaches operational status. Scaled-down vehicles and materials research vehicles for the Mark 3 have been in flight test for more than a year on Douglas Thor, Thor Able and Atlas missiles. First Atlas squadrons at Vandenberg AFB will use copper heat sink Mark 2 re-entry vehicle, also developed by GE's Missile and Space Vehicle Department. Next group of Atlases, possibly including some Vandenberg squadrons and some for Warren AFB, Wyo., will use Mark 3. Still later squadrons will use an even more advanced re-entry vehicle. Mark 3 is first USAF cone to use ablating technique in which lightweight materials dissipate re-entry heat by passing directly from solid to gaseous state. Lighter body of vehicle permits higher re-entry velocities, heavier payloads, greater accuracy. Vehicle still retains characteristic blunt nose used to push shock wave ahead of surface. Cylindrical body has doubly flared skirt which increases dynamic stability. First missile to use the ablating technique was Army's Jupiter, soon to be deployed by USAF squadrons in Italy. Heavily instrumented Mark 3s are not designed to be recoverable.



New Mark 3 nose cone is rolled into place on dolly on launch stand prior to being hoisted by gantry crane for placement on Atlas 18-D. Last week's flight was first test of full-scale ablating cone. Series of Mark 3s will be flown but will not be recovered.

Atlas Nose Cone Tested in Full-Range Flight



Atlas 18-D lifts off launching pad at Cape Canaveral in first test of new nose cone which succeeds Mark 2 heat-sink type.

NASA Launches Little Joe Test Vehicle

Washington – National Aeronautics and Space Administration destroyed a boilerplate model of the Project Mercury capsule at an altitude of 40 mi. after it was launched by a Little Joe booster in the first of a series of Little Joe shots from Wallops Station.

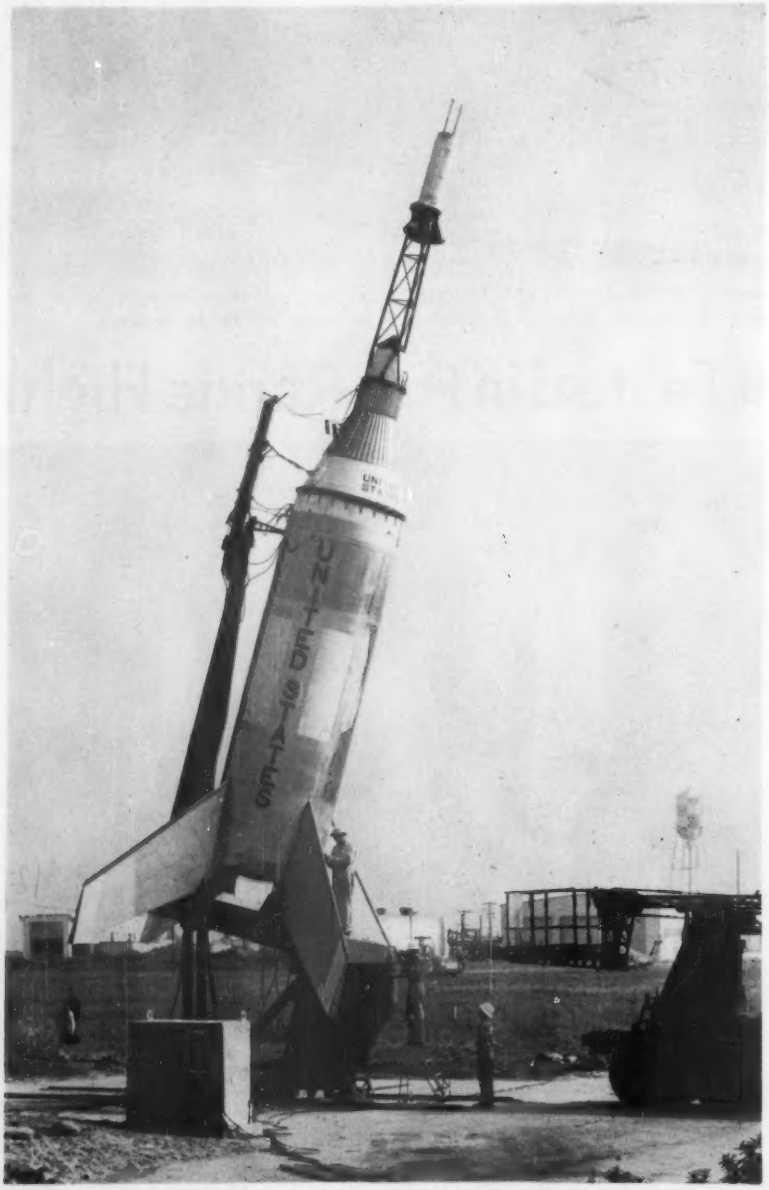
Intentional destruction of the Mercury capsule and its booster after about two and one-half minutes of flight was termed a successful operational test of the booster launching and destruct systems. Boilerplate capsule had an inert escape system attached, and neither the capsule nor the escape system was instrumented.

Mercury test vehicle was destroyed after burnout, but the capsule was not separated from the booster. Next Little Joe test will involve an instrumented capsule that will separate from the booster and provide a test of the Mercury system through a full ballistic flight cycle.

Little Joe launch was actually the second test scheduled in the series. First test was aborted in August when a spurious signal ignited the escape rocket prematurely and the capsule was lifted off its Little Joe booster and fell in the Atlantic Ocean off Wallops Station (AW Aug. 31, p. 33). The booster was not damaged, and it was modified and used in the second test.

The Little Joe booster was built by the Missile Division of North American Aviation, and powered by a package of eight clustered Thiokol Chemical Corp. solid propellant rockets. Basic power was provided by four Pollux motors, augmented at launch by four smaller Recruit rockets. The combination produced about 250,000 lb. thrust. The fin-stabilized booster was 55 ft. long and weighed about 20 tons at launch.

Future Little Joe booster will use the Thiokol Castor rocket, a motor which is similar to the Pollux but more powerful. Castor uses a polybutadiene-acrylic acid propellant binder, and Pollux uses a polysulfide propellant binder.



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION'S Little Joe booster is prepared to launch a boilerplate model of the Project Mercury capsule from the NASA Wallops Island, Va., station. Mercury vehicle was destroyed at an altitude of about 40 mi. in a test of the booster-launching and destruct systems.

Lockheed to Make Nuclear Rocket Study

Washington – Lockheed Aircraft Corp. will study the effects of radiation and low temperatures on possible nuclear rocket materials for the National Aeronautics and Space Administration.

NASA is currently negotiating a contract with Lockheed that calls for basic engineering work in a continuing feasibility study of nuclear rocket systems. The Lockheed study is expected to require more than three years and cost over $1 million.

Principal work will be carried out at NASA's Plum Brook Reactor Facility near Sandusky, Ohio, and Lockheed will be responsible for designing, installing and operating the test with NASA's 60 mw. test reactor. The company plans to conduct some preliminary test work at its Marietta, Ga., plant.

Lockheed will study the behavior of various materials at very low temperatures while they are exposed to reactor radiation. Temperatures in the –425F range will be encountered by several components of a nuclear rocket system using liquid hydrogen as a propellant.

Other work to be performed for NASA by various companies and agencies includes these contracts for research, services and equipment awarded in August:

- **University of Michigan,** $130,000, investigate radar methods of exploring the moon and other planets.
- **Yale University,** $150,000, satellite

and planetary motion investigations.

• **California Institute of Technology,** $120,000, research on rarified gas flows.

• **Case Institute of Technology,** $180,000, research on hybrid numerical circuitry.

• **Rensselaer Polytechnic Institute,** $60,000 continuation of research on dispersion-strengthened materials.

• **T. R. Finn & Co.,** $100,000, develop techniques for fabrication of refractory coated metals.

• **Aerolab Development Co.,** $240,000, rockets for sounding rocket research.

• **University of Colorado,** $110,000, instrumentation to measure ultraviolet radiation from high-altitude rockets and satellites.

• **University of Rochester,** $120,000, research on solid state photo detectors for orbiting astronomical observatories.

• **University of Chicago,** $70,000, preparation of a basic lunar map.

• **Jet Propulsion Laboratories,** $70,000, antenna conversion equipment.

• **JPL,** $280,000, purchase of equipment for use in tracking communications satellites.

• **Atomic Energy Commission** (University of California), $90,000, studies of biological life-support systems in an interplanetary environment.

• **Aero Geodesic Astrophysical Corp.,** $50,000, furnish radar tracking beacons and engineering services.

• **AEC,** $80,000, Salton Sea range costs for Project Mercury drop tests.

• **Aerolab,** $70,000, Booster hardware used in Project Mercury development.

Minuteman Silo Test

Edwards AFB, Calif.—A second full-scale model of Air Force's Minuteman ICBM has been fired successfully from a test silo here in continuing trials to check out environmental factors associated with underground launch of this solid-propellant weapon system. Effects of acoustic and pressure phenomena are key considerations in the environmental details under investigation.

Test silo used for the second firing was 12 ft. in diameter—much closer to the operational silo configuration for the Minuteman than the 16-ft.-dia. hole used for the first test of the Minuteman model (AW Sept. 21, p. 34). Negligible deviation-distance of the missile model from the silo lip in the first test indicated that the second launch could be made under the more realistic conditions of the smaller-diameter silo.

Silo holes are 26 ft. in over-all diameter, but installations such as elevators and ladders limit firing diameter.

In the tests, the Minuteman first stage is only partially loaded with propellant—just enough to accomplish launch from the silo. Second and third stages are dummies.

ARDC Shifts Project Authority To Four New Operating Divisions

By Craig Lewis

Washington—Air Research and Development Command is in the midst of a reorganization that will shift operating authority from headquarters to four new divisions and is expected to tighten Air Force's management of its weapon system programs.

Reorganization will centralize authority, responsibility and resources at the operating level so that a package management job can be done on a single system, using the concept of concurrence. Similar systems and functions will be grouped together in the four divisions (AW Aug. 17, p. 25), and each division will be headed by a deputy commander of ARDC who can exercise the authority of ARDC Commander Lt. Gen. Bernard A. Schriever in his particular area.

ARDC shuffle has been expected since Gen. Schriever assumed command six months ago (AW May 25, p. 25), and it reflects a number of recommendations in the 1958 Stever Report which recommended a reorganization of the command. It also reflects the experience and philosophy Schriever acquired from his command of the Ballistic Missile Division during the period BMD was developing an integrated management approach for the ballistic missile programs.

Operating Authority

Under the reorganization, ARDC headquarters shifts to a chief of staff organization from its former deputy commander structure. Operating authority is shifted to the deputy commanders who will command these four centralized divisions:

• **Ballistic Missile Division,** which will continue to manage ballistic missile and space programs.

• **Wright Air Development Division,** which will manage all aeronautical and related systems and will be formed by combining the directorate of systems management with major elements of Wright Air Development Center.

• **Research Division,** which will manage all basic research programs and will include the Office of Scientific Research.

• **Command and Control Development** Division, which will manage all communications and electronic control systems and will be organized around elements of the present Cambridge Research Center.

Gen. Schriever said last week that the major objective of the reorganization is to cut lead time between initiation of a program and delivery of the system into the operational inventory. New management procedures are being established to accomplish this objective, and Schriever said many of the procedures and philosophies used by BMD are being applied to the over-all command structure.

Centralized operating authority on the division level is a key element in the plan.

Gen. Schriever said he considers the concept of concurrency the one area of great importance in compressing lead time. Concurrency involves an integrated planning, programing and budgeting job, taking into account development, test, production, supply and operational environment problems. He cited the BMD record as a recommendation for the concurrency concept and said it should be applied to all major weapon systems.

BMD Record

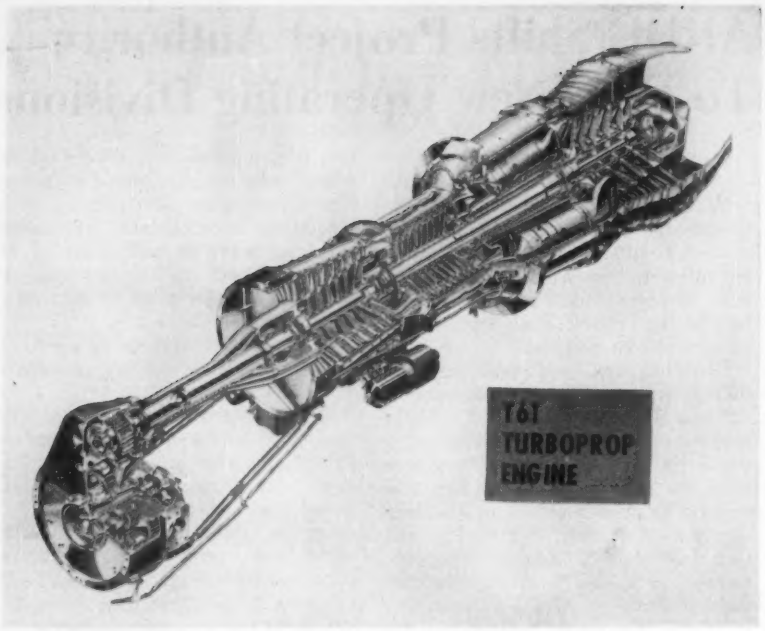
Discussing the BMD record, Gen. Schriever noted that the Atlas was about a five year program, and the Thor was developed in just over three years. "If you compare that to some of our other programs which run eight, nine, 10 years, why, you get some idea that you can, through management, do an awful lot in reducing the time cycle."

Gen. Schriever said that industry will continue to do the major development and testing job for the Air Force, but under the new ARDC approach, USAF will have "much stronger management capability within the Air Force by using our in-house capability for supervising and managing those programs." He said his aim is to "give a tighter control and tighter supervision of the programs which industry will be carrying out for us; in other words, a better utilization of our in-house capability."

The ARDC commander said there will be stronger management supervision from the new divisions "similar to the management supervision that is exercised at BMD at the present time."

ARDC will continue to contract for technical support from such companies as Space Technology Laboratories. Gen. Schriever plans to use both USAF and contractor personnel to provide the technical staffs for the four divisions, and no change is expected in contractor arrangements at such facilities as Arnold Air Development Center and the Atlantic Missile Range.

The various ARDC centers will be assigned among the four divisions in the final phase of the reorganization, sometime within the coming year. Just how



Air Force Extends T61 Development Contract

Air Force has extended the contract for development of the Allison T61 6,500 shp turboprop engine to Nov. 30, and development may continue beyond that date. The contract expired two weeks ago (AW Oct. 5, p. 33). The T61 is the projected powerplant for Lockheed's Super Hercules freighter. Lockheed said negotiations for extension of contracts for orders were going on with Slick Airways and Pan American World Airways.

a center with dual functions will be assigned is not yet clear, but it appears that a center such as Edwards AFB, Calif., would have to be split, with the aircraft flight test activities run by Wright Air Development Division from Dayton and the rocket engine test activity by BMD from Inglewood.

ARDC realignment is one of a series of reorganizations among various USAF elements to improve management techniques. Earlier this year, Air Force split its requirements function and gave responsibility for developing short-term operational requirements to the deputy chief of staff, operations. Responsibility for developing longer term system development requirements remained with the deputy chief of staff-development.

Air Materiel Command reorganized its management structure last year and separated policy and operational elements. Under this system, operational AMC units cooperate closely with related ARDC units in the procurement role. AMC's Ballistic Missile Center works with BMD, and the Aeronautical Systems Center will be working with WADD. A similar AMC unit will be established to operate with the Command and Control Development Division at Boston.

The current reorganization was launched last May shortly after Gen. Schriever took command. A task group studied all previous reorganization and management recommendations, and a new pattern for ARDC was completed in August. The plan has been in Pentagon channels since then. Gen. Schriever said no substantive recommendations were turned down, although a few minor refinements were made. The plan picks up some of the key recommendations of the Stever committee, especially those dealing with the shift of authority from top policy echelons to the operating units. It diverges from the Stever Report, however, in organizing the divisions along system lines rather than by function.

First step in the plan is reorganization of ARDC headquarters, a job that is well under way. With the new chief of staff organization, former deputy commanders in headquarters become deputy chiefs of staff. ARDC headquarters will concentrate on its staff function of policy and program supervision, and the direct management of programs passes to the division level.

Air Defense Systems Integration Division will remain a separate entity under ARDC headquarters, and ADSID chief Maj. Gen. Kenneth P. Bergquist will remain as a deputy commander.

Second phase involves organization of the new divisions. BMD is about ready to go, but it will take 30-60 days to form WADD at Dayton and the Research Division in Washington. These divisions will take over the systems they will manage as soon as they have been sufficiently organized.

Commenting on Wright Air Development Center's role in the new structure, Gen. Schriever rejected implications that WADC is being downgraded and said that after the consolidation of WADC and the Aeronautical Systems Division into Wright Air Development Division, the group will have greater responsibility and greater authority. He said that total resources assigned to ARDC in the Dayton area "will be used to a greater and a more important extent than they have been in my opinion in the past. . . ."

Since the Command and Control Development Division cannot be based on a currently operating management organization, it will take longer to organize and probably won't be operating for another six months. After all divisions are established and operating, the centers will be assigned among them. Assignment of the centers is the final phase of the reorganization program.

BMD will remain under the command of Maj. Gen. O. J. Ritland. WADC chief Maj. Gen. Stanley T. Wray will command WADD, and Air Force Office of Scientific Research commander Brig. Gen. B. G. Holzman will head the Research Division. Commander has not been named for Command and Control Development Division.

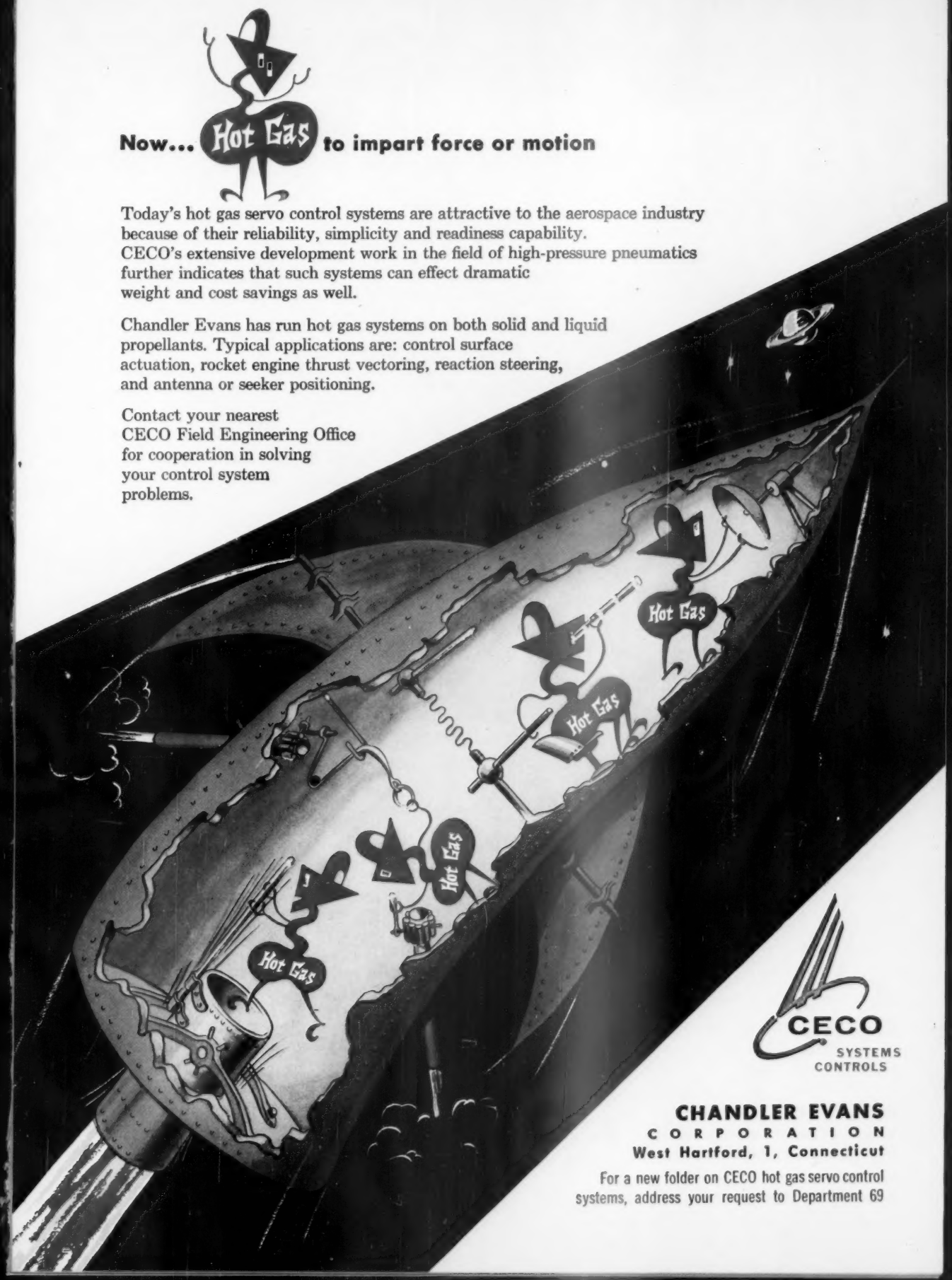
Boeing Briefs Bidders On Minuteman Details

Seattle, Wash.—Details of the Air Force's mobility concept for the Minuteman solid-propellant ICBM were discussed by members of Boeing Airplane Co.'s Aero-Space Division, Materiel and Engineering Departments at a bidders' conference here.

Discussions were conducted on subcontract work connected with Boeing's portion of the Minuteman research and development program.

Selection and announcement of the subcontractor will be made in November pending evaluation of proposals

Companies represented included: AFC Industries, Inc., New York; Allis Chalmers Mfg. Co., Milwaukee, Wis.; Baldwin-Lima-Hamilton, San Francisco; Bethlehem Steel Co., Bethlehem, Pa.; the Budd Co., Philadelphia; Chrysler Corp., Detroit; Consolidated Western Steel Corp., Los Angeles; Fairbanks, Morse & Co., Chicago; Firestone Tire & Rubber, Los Angeles; Food Machinery Corp., San Jose, Calif.; General American Transportation Corp., Chicago; General Motors Corp., Detroit; Lockheed Aircraft Corp., Burbank; Magor Car Corp., New York; Ortner Co., Cincinnati; Pacific Car & Foundry, Renton, Wash.; Pullman Standard Mfg. Co., Chicago, and Thrall Car Mfg. Co., Chicago.



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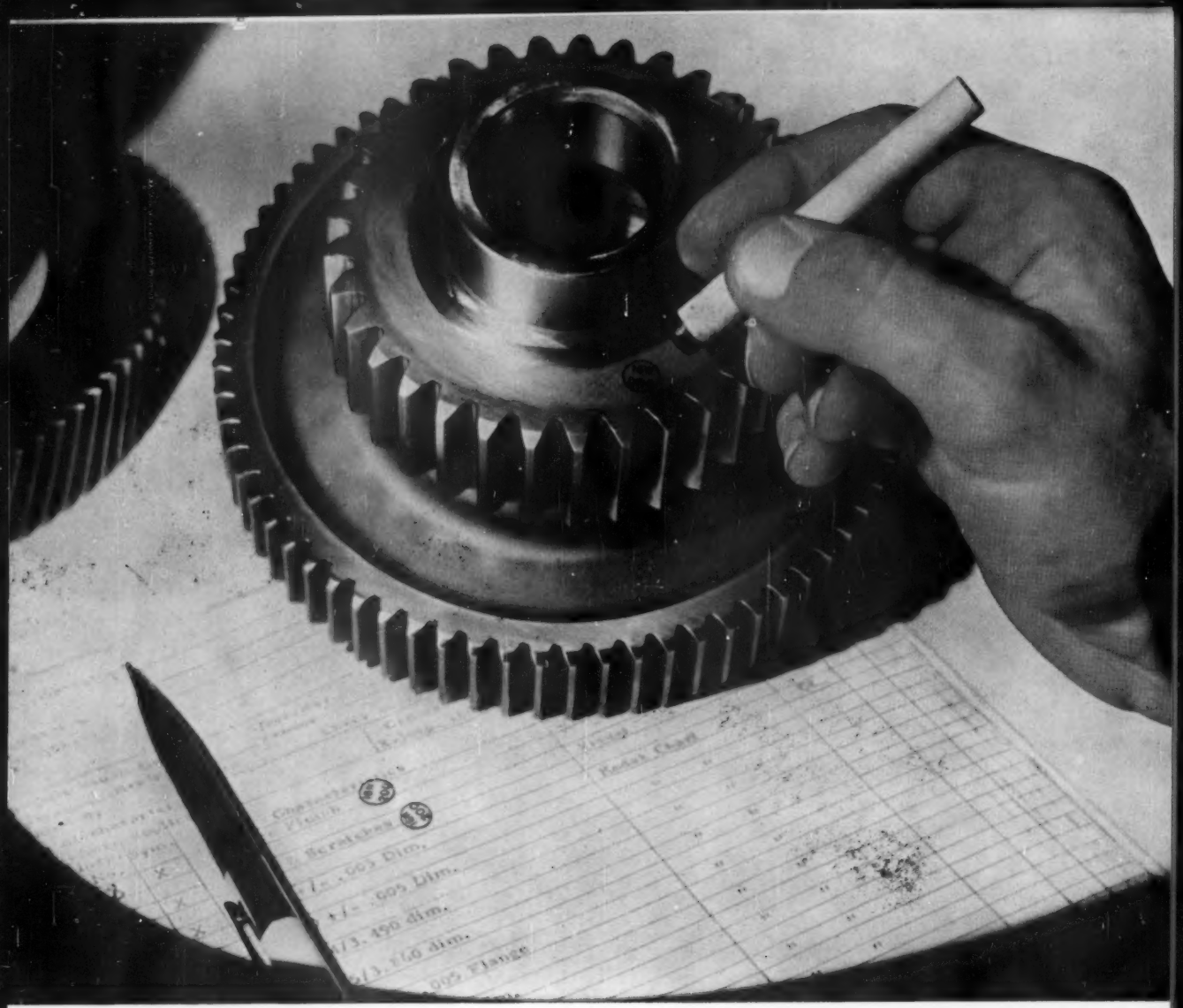

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Civil Sabreliner Planned for Late 1961

Minneapolis—Marked impact of turboprop and turbojet aircraft in the executive flying field was underscored here last week when North American Aviation said it would offer its twin-jet Sabreliner for commercial use.

Arthur R. DeBolt, Sabreliner program manager, said current projections indicate a commercial model could be delivered by December, 1961. Sabreliner now is in production for U. S. Air Force, which has ordered 42.

The plane will be offered, he said, when the military program has been established to a point where firm prices and delivery can be determined.

Final decision on commercial aspects of the Sabreliner project (AW Oct. 5, p. 23) will be made by North American directors on Nov. 24 at Los Angeles.

Turboprop Experience

The 1961 delivery date, DeBolt added, could be met by releasing materials for production on Sept. 15, 1960. He said Air Force program results and data will be monitored by Federal Aviation Agency; certification is expected by Mar. 31, 1961.

Operation costs and flight experience on turboprop-powered planes—both corporate and airline—was a major topic at opening sessions of the 12th annual meeting of the National Business Aircraft Assn.

PacAero has 10 firm orders for conversion of Convair 340s and 440s using Allison 501-D13 turboprops. Nine more are under varying degrees of negotiations; most are for corporate users.

The plane will sell for about $490,000. Vernon B. Benfer, PacAero president, said Braniff is interested in four of the planes. Under a unit exchange program, he said, Allison's Indianapolis facility will supply engines to operators on demand, thereby reducing the operator's inventory.

Benfer said the first production plane will fly early in January; certification is expected by Mar. 4, after an anticipated 65 hr. of flight time for FAA tests. The Allison-powered Convair has received more than 1,000 hr. of test time through utilization of an Air Force YC 131-C, leased by Allison.

During "Operation Hourglass," the plane logged 1,000 hr. in 84 days and 649 flights, according to J. D. Beaumont, Allison commercial sales manager.

Present production plans call for three planes per month.

Speaking for Fairchild Engine & Airplane Corp., P. C. Mack, corporate sales manager, said transition problems for corporate pilots checking out in the F-27 turboprop transport have been "negligible." He said pilots have passed air transport rating tests after as little as 5 hr. flight time. Turning to airline experience, Mack said there have been no major operating problems; airplane No. 3 has 105 service bulletins issued and that figure has dropped to 15 for airplane No. 50.

In a move toward wider executive use of turboprops, the manufacturers have set up pilot and maintenance schools—Fairchild at Hagerstown, Md., Grumman, for its Gulfstream, at Bethpage, N. Y., and Rolls-Royce, for its Dart engine, at Montreal, Can.

Rolls-Royce said it has tested an advanced Dart version, the RDa.10, for 150 hr. reaching 2,860 eshp. The company expects to increase this to 3,000 eshp. by use of water-methanol injection.

Another improvement will be a system to air-cool the turbine blades, allowing an increase in flame temperature without a commensurate increase in blade temperature.

A Napier Engines, Inc., spokesman said the Eland turboprop used on Allegheny's Canadair 540 conversion has performed "better than brochure."

The only engine mishap delaying the single-plane operation, he said, was damage caused when vortex pulled an access door into a propeller.

JetStar Sales Program

Lockheed Aircraft pitched its four-jet JetStar at what is called a "wide-world" executive operation. The company is offering, as optional equipment, a second DME-T and an HF transceiver for overseas operations.

The plane will cost $1,174,330 with dual communication-navigation equipment. It was learned here Lockheed now has about 40 firm orders. Prototype No. 1 was on display at Wold-Chamberlain Field. Pratt & Whitney JT12 engine for the No. 2 prototype will be delivered next week.

F. A. Cleveland, chief of advanced design engineering at Lockheed's Georgia Division, said modifications will include a change from the present single wheel landing gear to a dual configuration. The company also has run considerable tests with leading edge slats and this feature will be incorporated on production models.

Clamshell-type thrust reversers for the JT12s now are under development at Rohr Aircraft, he said.

Cleveland said the JetStar costs $500 an hour to operate but actual costs will be less than $1.10 per mile, figuring the plane's 500 mph. speed and capability of flight at altitudes up to 35,000 ft.

He said future modifications possibly will include installations of water injection in the JT12s to improve hot-day performance. Another possibility is utilization of J85 turbofan engines, or perhaps a turbofan which would be developed from the JT12 family.

Production planes, Cleveland added, also will include pressurization of the nose compartment to allow avionics equipment to operate at sea-level pressures.

Transition of business aircraft operators from the DC-3, Lodestar and converted World War II surplus aircraft to the first generation of turbine-powered equipment was emphasized with the presence here of the Grumman Gulfstream, Fairchild F-27 and Lockheed JetStar.

The trend was further emphasized by a representative of one of the major U. S. overhaul and modification firms

Safety Devices Urged

Minneapolis—The need to get working equipment, particularly devices such as runway takeoff monitors and proximity warning indicators, into the cockpit now, to cut the aircraft accident rate, was urged by Maj. Gen. Joseph D. Caldara, deputy inspector general for safety, USAF.

Critical of what he termed "paralysis by analysis" as the major reason for the lack of in-service equipment, Caldara, speaking before the 12th annual meeting and forum of the National Business Aircraft Assn. here last week, warned pilots and executive aircraft operators that their transition into turbine-powered equipment will place greater emphasis on piloting skill and the need for the latest equipment in the cockpit to enable the pilot to "stay ahead" of the airplane.

Indicating impatience with the long development time occurring on vitally-needed cockpit equipment such as proximity warning and runway monitoring devices, he noted, "you can't prevent accidents in 1959 with 1963 equipment."

As if to point up the problem discussed by Gen. Caldara, a later discussion on air traffic developments by Col. Carl Fisher, Federal Aviation Agency, Plans and Programs Division, Bureau of Research and Development, noted that on the proximity warning program alone, the bureau had looked over some 180 different equipment proposals by industry—of which approximately 20 are considered good enough for further evaluation.

LATEST BEECH entry into business flying field is the six-passenger Model 65 Queen Air medium twin. Powered by 340-hp Lycoming engines, airplane will cruise at 214 mph. at maximum weight. Range is more than 1,000 mi. Deliveries will begin early next year.

who told AVIATION WEEK that his management was now seriously debating how it should realign facilities to de-emphasize work on DC-3, Lodestar and similar-category aircraft in order to prepare for the increasing numbers of turbine-powered airplanes coming into service.

Some overhaul plants already are preparing to fit into this era—as shown by Airwork's $500,000 modernization program to provide facilities for handling the Rolls-Royce Dart, Pratt & Whitney Aircraft JT12, the new PT6 turboprop, and similar programs by Pacific Airmotive Corp. and Southwest Airmotive Corp.

Avionics firms also are feeling the increased demands by new buyers of turbine-powered aircraft for sophisticated and costly new equipment. As if to point up this potential, there is recent purchase of a $29,000 General Precision Laboratory Radan 500 and TNC-50 radar doppler system and track navigation computer by a major corporation for its soon-to-be delivered Grumman Gulfstream—first executive aircraft installation of this product.

As the first generation of large multi-engine turbine-powered executive aircraft starts going into service, first indications appeared here at the NBAA forum, of the second generation—the smaller light and medium-twin class.

These signs were apparent in the display of small powerplants such as Allison's 250-shp. T63 and Canadian Pratt & Whitney Aircraft's PT6, with 500-shp. takeoff rating and the interest shown in these new engines by business aircraft manufacturers.

"It now looks like we will be independent of foreign engine designs," one manufacturer's design engineer told AVIATION WEEK. However, a consensus of opinion by aircraft manufacturers indicates that although the engine manufacturers are saying they will be able to furnish flight test quantities of the new small powerplants sometime in 1961, production airframes powered by these engines are not likely to be coming off the line until approximately 1964.

First class of airplanes to take the new engines probably would be six-to-eight seat pressurized configurations using at least 500-600-shp. Designers now seem to feel that there would not be a sufficient performance gain in switching from 250-300 hp. piston powerplants to equivalent power turboprops to justify their early use—and price would also be a major factor.

Beech Aircraft Corp. made the first public showing of its new medium-twin Model 65 Queen Air at the NBAA forum, breaking tradition in that the company previously gave its dealers and distributors first showings of new equipment at annual sales meetings at the Wichita factory.

Queen Air deliveries will begin in early 1960, with the list price of a basic airplane being $120,000—full equipment could run this up another $25,000. The six-passenger airplane, powered by 340-hp. Lycoming supercharged fuel injection engines, has a maximum gross weight of 7,700 lb. and a range of over 1,000 mi.

At maximum weight, the Queen Air is designed to cruise at 214 mph. at 2,750 rpm. at 15,200 ft., and will have a maximum speed of 239 mph. at 12,000 ft. Two-engine rate of climb is reported as 1,300 fpm. Stall speed, with landing gear and flaps down, is 84.5 mph.

Among new equipment displayed for the first time was a small Sperry autopilot, the SP-3, which will be available in single, two and three-axis "building block" configurations for single and light-twin business planes. Sperry reports that cost of the three-axis unit will be under $4,000 and it expects that deliveries will begin in early 1960. Single-axis unit will be approximately $1,550. Unit is now undergoing flight tests in a Piper Apache. Weight of the fully transistorized equipment is from 11 lb. to 27.5 lb., including flight instrumentation, depending on the number of axes desired. Instrumentation includes Sperry air-driven directional and attitude gyros.

Business flying safety record was highlighted during the presentation of awards to 77 NBAA member pilots for completing one million or more miles of flight without accident or injury and to 88 pilots for having safely flown 500,000 mi. or more. Total safe mileage flown by the pilots receiving the awards from NBAA was 165,620,468.

In addition, the Women's Aeronautical Assn. of Kansas conferred its annual business flight safety award this year to Arthur E. Abney, director of Department of Aeronautics, Illinois, for his programs in the state which are considered responsible for having reduced the private and business flying accident rate 31% in the face of a 32% increase in the number of registered pilots in the state.

Elected president of NBAA was B. J. Bergesen, Ford Motor Co., replacing Joseph B. Burns, Fuller Brush Co. The association announced that its annual meeting next year will be held in Los Angeles, in Tulsa in 1961 and Pittsburgh in 1962.

Military Criticized For Decision 'Surrender'

New York—Surrender by the military of its responsibilities for defense development and an "undue adulation" of the nation's scientists were criticized last week by Lt. Gen. Leslie R. Groves, USA (ret.), at an American Management Assn. convention here.

Gen. Groves, now a Remington Rand vice president, said it is unsound for the nation to permit its major military decisions to be so greatly influenced by persons with little, or no military background, especially when military men are almost completely removed from positions of influence.

"Fortunately, many of the companies engaged in military research and development have employed retired officers with a lifetime of military service behind them," he said, stressing that this is in the best interests of the military as well as industry.

He said the military has slowly surrendered its responsibilities for:

- **Establishing** military requirements in technical developments.
- **Supervising** development programs to see that these requirements are met.
- **Cutting costs** of development and seeing that it does not lag.

Gen. Groves said the Defense Department now employs more senior civilian officials than it does senior military officers, and that civilian opinions were probably outweighing these military influences.

"This is not the fault of industry," he said. "It is the fault of all of us in permitting this undue adulation of the scientist to grow up and to continue.

"Certainly the progress of development since the war, considering the amount of money that has been spent, has not been so great as was accomplished during the war. Probably one of the reasons for this has been the diminishing influence of military persons on such work."

Russians Negotiating For Sikorsky S-58s

Washington—Soviet Embassy last week opened direct negotiations with Sikorsky Aircraft Division of United Aircraft Corp. for the purchase of "a few" S-58 helicopters. The helicopter, used by President Eisenhower, won the admiration of Soviet Premier Nikita Khrushchev during his recent U. S. visit. After flying in the President's S-58, Khrushchev said he liked the flights "and the helicopter itself" and would like to buy one (AW Oct. 5, p. 25).

Following up on the Premier's wish, Soviet Ambassador Mikhail Menshikov called on Deputy Under Secretary of State Livingston Merchant last week and was directed to Sikorsky. Menshikov then turned over negotiations with Sikorsky to Vladimir Alkhimov, Soviet commercial counselor.

Alkhimov said he will negotiate for the purchase of three aircraft. He told AVIATION WEEK that, while he was not familiar with the Soviet Union's own 10-passenger Mi-4 helicopter, "we want a helicopter similar to the one your President uses." The President's S-58 has a maximum capacity of 12 persons, but only eight fly when he is aboard as a safety precaution.

The commercial price is $267,000, exclusive of numerous additions for safety and comfort that have been incorporated in the President's aircraft. These include additional radio, compass, flight instrument and air conditioning equipment, interior cloth lining and carpeting.

Aerojet to Fabricate Four Astrobee-500s

Air Force Cambridge Research Center has awarded Aerojet-General Corp. a contract for design and fabrication of four Astrobee-500 sounding rockets. It is expected that the first of these vehicles will be launched late this year from Eglin Gulf Test Range, Fla. Three-stage Astrobee-500 achieves maximum altitude of 500 mi. with a 40-lb. gross payload. Performance varies as payload weight changes, and a 450-mi. peak altitude is achieved with a 70-lb. gross payload at 5 deg. launching angle from sea level. Over-all length is 25.5 ft. Aerojet's Systems Division is now working on preliminary design of an Astrobee-1,000.

News Digest

Northrop International Division and Norair Division of Northrop Corp. made a formal presentation of the N-156F last week to a Japanese evaluation team at Edwards AFB, Calif. Gen. Minoru Genda, chief of staff, Japanese Air Self Defense Force, flew two flights in the aircraft for 50 and 45 min. respectively. Maj. A. Ogawa flew one flight in the N-156F for about 35 min. All flights included supersonic runs.

First F-104 Starfighter has been turned over to West Germany by Lockheed Aircraft Corp. under its 96-plane contract with the German air force. The West Germans will manufacture 200 more F-104s under license.

USAF Chooses JetStar

Washington—Air Force last week announced that it has chosen the Lockheed Model 329 JetStar over the McDonnell 119A to meet its requirements for a turbine-powered navigation trainer, but no decision has been made as to whether to procure any in Fiscal 1960.

Ultimate decision will depend upon a re-examination of the requirement and its priority in relation to other USAF programs and available resources. The 329 is powered by two Curtiss-Wright TJ37 engines. Final configuration, however, will use four Pratt & Whitney JT12s.

British Ministry of Supply has placed production order for the Blackburn NA.39 low-level strike bomber for the Royal Navy. Aircraft was rejected by RAF as too slow with too short range. Contract is additional to the development batch of 20 already on order.

Indian navy is expected to announce an initial order for 15 Breguet Alize anti-submarine aircraft. Three-place Alize is powered by a single Rolls-Royce Dart turboprop. French Navy has ordered 75, of which about 20 will be delivered by the end of 1959. Breguet Alize production rate now is running at four aircraft per month.

Kaman Aircraft Corp. has received a $1.9 million Air Force letter of intent for delivery of 42 H-43B helicopters during Fiscal 1961. Firm contract price, now under negotiation, is expected to be about $10 million.

First U. S. steerable radio telescope designed specifically for solar research was dedicated last week at the University of Michigan's Peach Mountain radio astronomy facility 16 mi. northwest of Ann Arbor. The unit, an 85-ft. parabolic antenna built with Navy support, has the capability of making a detailed study of weak centimeter-wave bursts of radio frequency noise that often accompany solar flares. Telescope also incorporates a ruby maser radiometer developed by the university's Willow Run Research Laboratory that will almost triple its normal range. Research will be conducted under an Office of Naval Research contract.

Vice Adm. Clarence E. Ekstrom, former commander of the U. S. Sixth Fleet, has been named commander, naval air forces, Pacific Fleet, succeeding Vice Adm. Alfred M. Pride. Adm. Pride, who had held the post since February, 1956, recently retired after 42 years of Navy service.

Increase in Seat Capacity Alarms IATA

Delegates to general meeting fear climb in world's available seat miles will outstrip growth of new traffic.

By L. L. Doty

Tokyo—Fifteenth annual general meeting of the International Air Transport Assn. opened here today in an atmosphere of doubts over the industry's ability to cope with the large-scale expansion of aircraft seat capacity scheduled during the next two years.

With operating losses of the world's scheduled airlines last year at an all-time high of $160 million, delegates to the meeting are deeply concerned that the sharp climb in available seat miles will rapidly outstrip the growth of new traffic as more turbine equipment is inaugurated on global routes this year and next. Member airlines of IATA will introduce a total of 300 new turbojet aircraft by the end of 1960 with an additional 200 earmarked for delivery by the end of 1963.

This vast increase in seat capacity pinpointed lower fares as the key to generating new traffic and as a means of boosting load factors above the break-even level. However, strong disagreement exists as to which areas throughout the world would react to lower fares to a degree that new traffic would automatically result.

This issue was a controversial point during the IATA traffic conference which closed in Honolulu last week. In talks with traffic conference delegates in Honolulu, AVIATION WEEK learned that an earlier drive toward lower fares lost momentum during the meetings because so many doubts were cast over the ability of many areas, particularly Africa, to generate any more traffic than is now available no matter how low the fare level might be set.

Nevertheless, jet surcharges will be eliminated—a fact that will arouse some protest from U. S. domestic carriers which are enjoying an unexpected revenue bonanza as a direct result of the extra charge. In addition, international carriers are about ready to drop fare differentials. They will, however, put new emphasis on developmental or promotional rates in a move to create new tourist traffic.

In his opening remarks during the plenary session of the general meeting, IATA Director General, Sir William P. Hildred, stressed the issue of low fares but recognized the problems posed by the big increase in available seat miles. He said:

"We need larger markets; in order to get at them, we must have lower fares. We are therefore buying new types of equipment which promise lower operating costs per seat mile. But we must, at the same time, take on much higher productivity and we know that we can get those lower operating costs only if that capacity is fully utilized. And this means that we must get fares down even further. This is a full circle, but not necessarily a vicious one, for with price as the determining factor, we all know the traffic is ready and waiting."

Turbojet Costs

Not all carriers were ready to concede that the turbojets promised "lower operating costs per seat mile." This was particularly evident in Honolulu at the traffic conference where a number of delegates representing airlines which have not yet taken delivery of the new aircraft were reluctant to join proponents of lower fares at this time.

Their attitude was one of "wait-and-see" and, while admitting a desire to see an expansion of the North Atlantic economy fare plan to other parts of the world, they expressed a preference to hold off supporting the proposed rates until they had behind them some experience with actual operating costs of the turbojets on their routes.

Nevertheless, Hildred pushed hard for a wider use of the economy plan, following the low-fare philosophy he has advocated for a number of years. He told IATA general meeting delegates, some 250 in all, that economy traffic on the North Atlantic during 1958 accounted for more than 55% of all traffic even though the lower rates were in effect for only nine months of the year. He added:

"They provided the impetus which pushed North Atlantic traffic ahead by 26.8% for 1958."

On the subject of capacity, Hildred said that a number of piston-engine aircraft have stayed within the scheduled commercial field since many sales virtually amounted to a transfer of the older planes from one operator to another.

He indicated charter flights might ease the problem of over-capacity by noting that:

"The existence of more equipment than is needed for peak demands of summer operations seems at this point to have made charter operation, particularly across the North Atlantic, heavy and competitive among scheduled operators this year."

He told the meeting that the capacity of aircraft next year will be "of an order which we have never been called upon to fill before" and added:

"Look at this against the background of 1958, when we carried more traffic than ever, yet ran less than 60% full. Then consider that each jet which comes into operation is the productive equivalent of three DC-7s. You will have an idea of what lies ahead. We shall have to feed progressively larger gobbets of traffic to these monsters or they will eat us up, capital and all."

In his report on the state of the industry, Hildred pointed to recent figures released by the International Civil Aviation Organization which indicated that all the airlines of the world, excluding the USSR and the Chinese People's Republic, were drawing close to a plateau in the development of passenger traffic. The statistics showed that passenger traffic in 1958 climbed an insignificant 2% compared with a 12% increase during 1957.

He also noted that U. S. domestic traffic experienced a drop during the year: from 45.3 million passengers in 1957 to 44.9 million last year. He had this to say, however, on the brighter side of the picture:

"Intra-European passenger traffic showed a healthy increase of 9% in 1958. North Atlantic results were even better. The total number of passengers carried on the scheduled and charter flights of the 17 IATA members operating between Europe and North America reached a new high of 1.2 million, an increase of 26.8%, as against an increase of 22% registered in 1957."

He cautioned, however, that 1958 was "not one of our better years whichever figures are taken (ICAO or IATA). But I will go on to say that the figures now available for the first half of 1959 and the early weeks of the summer, show traffic rising on an ebullient curve for both international and U. S. domes-

tic operations and the likely prospect of a good year, both in terms of total carryings and comparative rate of increase."

In the field of air traffic control, Hildred called upon governments to accelerate training of personnel to man air route traffic control centers as a first step toward easing of air traffic delays, especially over North Atlantic routes and in Europe. He charged that failure to build up efficient air traffic control crews had delayed the introduction of controlled air space on high-altitude jet routes.

He made reference to Eurocontrol as a logical step toward resolving the air traffic control problem and said:

"This, like Air Union, is an intelligent cooperative effort. The aim of Eurocontrol is an automatic electronic system which will greatly reduce the risk of collision between civil and military aircraft at high altitudes and I hope the system will develop speedily and keep up with the number of jet passengers who will take to the upper air."

On the subject of increasing user charges at a growing number of airports throughout the world, an issue which consistently plagues delegates to IATA general meetings, Hildred charged some governments with insisting upon lower fares—in some cases lower than the carriers seek—while, at the same time, allowing departments of the same government to set higher landing fees or landing charges against these carriers. He warned:

"If . . . the governments charge us, we must pay, but I would remind them that the more we pay, the less we shall be able to do to maintain their communications and bring to them the benefits of tourism and commerce."

Strong Position

Hildred took a strong position on behalf of the traffic conferences in an obvious reference to criticism aroused by failure of last year's traffic conference at Cannes to reach a settlement of jet surcharges (AW Oct. 27, 1958, p. 26). He said, "fifteen years of traffic conferences convince me that however baffling a situation may appear, solutions can be found by hard work and the desire to get agreement." He praised the "non-political atmosphere" of the traffic conference and the non-interference of governments, and added:

"World-wide international agreement on fares and rates will never be popular. From time to time some nation or some airline, proud of its achievements, will resent the fact that it cannot get everything it wants because 90 others have a say in the matter . . . we must expect, from time to time, competitive friction, government against government, government against airline, airline against airline, but this is not a bad thing."

Western Ready to Buy Turbojets; Orders Depend on Route Awards

Los Angeles—Western Air Lines, now ready to enter the turbojet market, is evaluating both the Convair 880 and the Boeing 720 transports as a major step in its long-range re-equipment program.

No decision has yet been made as to the number of new aircraft that will be ordered since the carrier's basic requirements will be determined largely by its success in winning new route awards on petitions now pending before the Civil Aeronautics Board. For example, a route between the West Coast to Honolulu, which Western is vigorously seeking, would raise its minimum requirements for either the Boeings or Convairs by at least four new airplanes.

Growth Trends Eyed

In addition, Western President Terrell Drinkwater is watching the current spectacular traffic growth trends with a wary eye since he has no intention of getting caught short with more seats than he can sell. Drinkwater told AVIATION WEEK that he feels a "plateau" in the presently available travel market has already been reached and that the overdose of available seat miles which the domestic trunklines will inevitably produce during the next two years will depress load factors substantially unless new markets are opened.

Job of opening these new markets has been delegated to Arthur Kelly who is meeting this challenge with a series of revolutionary ideas all based upon one philosophy: Western has gone beyond the air transport business and is now in the travel business.

Such a sales approach should not suggest a departure from the basic conservatism that has marked Western's expansion programs in the past. Translated into Drinkwater's principles of operation, this conservatism means that the airplane Western finally chooses will be the plane best suited—economically and operationally—to Western's routes and that no orders will be placed until financing is completed.

Why the Delay

Drinkwater has delayed joining turbojet competition until now for several reasons. Primarily, he wanted to make no commitments until he was certain the company was in a position to pay for the new fleet. Financial arrangements have been made for an initial order of turbojets. Secondly, Drinkwater felt that a carrier the size of Western could not afford to underwrite the shakedown costs which are an inevitable factor in the introduction of an entirely new airplane.

In addition, he felt that, once the initial rash of orders for jets had spent itself, manufacturers would have more in the way of fringe advantages to offer in working out contracts than they did originally.

And, finally, he believes the turboprop is still the most satisfactory model for the medium-haul routes which characterize Western's operations.

In this connection, he told AVIATION WEEK that he is convinced the turboprop aircraft will experience increasing popularity with passengers as the "novelty of the propellerless airplane wears off."

Western has nine Lockheed Electra turboprop transports on order, the last of which is scheduled for delivery in February. Drinkwater will take up the option on the additional three Electras he holds once delivery on the basic order is completed. The five Convair 240 transports now in scheduled service will be sold next year, but Western will retain its fleet of DC-6Bs for air-coach service to back up the turbine equipment which will be operated in first class configuration. Western has avoided combination first class/coach

Capital Turbine Order

Capital Airlines is scheduled to announce final purchase agreements this week for seven Convair 880 turbojet and five Lockheed Electra turboprop transports, Aviation Week has learned.

Delivery schedule for 1960 probably will be May through July for the Electras and October through December for the 880s, with scheduled service on the turboprop beginning in June and 880 service starting in December.

Financial arrangements for the purchase are nearing completion and Vickers Armstrongs, Ltd., is expected to approve a plan to extend Capital's payment schedule for the $37 million owed on its Viscount purchase. The loan being negotiated with U. S. sources for the turbine purchases will cover only the cost of the new aircraft plus spares and will not include assumption of the Viscount debt as discussed by Convair and Capital almost two years ago.

In a recent re-examination of its equipment program, Capital also held a series of discussions with Boeing Airplane Co. regarding the possible purchase of the 720 turbofan transport. With the final agreement with Convair, these discussions are being terminated.

configuration on all of its airplanes.

Thus far, Western has been able to offset the increase in available seat miles resulting from the introduction of Electras with substantial traffic increases. Revenues in August climbed approximately 17% as compared with a 5% increase in available seat miles, and during the first eight months of 1959, the carrier has reported the largest net earnings per share of common stock outstanding of any of the domestic trunklines.

Arthur Kelly, Western vice president-traffic and sales, has adopted a defined "research and development" sales program as an insurance against any future imbalance in the ratio of available seat miles to gross revenues. His studies have shown him that, whereas air traffic in the eastern areas of the U.S. has leveled off to a large degree, a growth factor in the western U.S. can be expected to continue for another two years.

Kelly, however, believes that the rapid increase in available seat miles produced by new turbine equipment will easily absorb this traffic growth and that new sales approaches must be adopted if a healthy demand for the growing supply of seat miles is to be maintained.

In this respect, he has dropped the "hard-sell," or "all or nothing," theory of selling and replaced it with what he calls the "half-a-loaf system."

In effect, Kelly believes that the sale of air transportation should be keyed to the sale of travel and that travel, to be convenient and attractive to customers, must include a wide range of facilities.

Air-Sea Tours

For example, he is cooperating closely with Matson Steamship Co. in the development of air-sea tours on the theory that it is easier to sell travel in such a package than it is to attempt to restrict a passenger to a single type of transportation in each direction. He feels that he can expand his markets by offering passengers a return trip on another airline as a means of attracting new sales with variety of travel. This is the "half-a-loaf" system which Kelly feels will help Western move from the airline business into the travel business.

The program is based on convenience to the customer. It is the reason he has single-handedly launched an expanded credit program (see p. 48). And it is the reason he is placing new emphasis on the role of the professional travel agents in the development of package tours or "half-a-loaf business."

Western's research program has pointed up a failing on the part of the airline industry to educate the traveling public on the lowness of air fares generally, according to Kelly. He admits that Western's campaign to promote champagne flights may have categorized Western's flight services in the "luxury" group—suggesting a highly-expensive service and thus unattainable to the average traveler.

In one customer survey, answers to the question "How can the airlines broaden their markets?," could be summarized in this way: "We will fly when we can afford to fly." As a result, Kelly's conclusions are, "We haven't done a good job in telling the public how cheap it is to fly."

As a first move toward correcting this deficiency, Kelly is now emphasizing in all his advertising and promotional material the fact that additional services are offered at "no extra cost."

Western is placing little or no stress on cargo development at the present time on grounds that air cargo over short-haul routes has minimum benefits for the average shipper. As a consequence, the airline has no intention of converting piston-engine aircraft into all-cargo aircraft or of operating an all-cargo service within the immediate future.

Western also is a strong proponent of an "all-up mail" system as the most logical means of efficiently utilizing cargo holds on passenger aircraft.

National Jet Surcharge Trimmed by CAB

Washington—National Airlines has been ordered to suspend its planned $10 surcharge for coach seats on Boeing 707-120 turbojet flights between New York and Miami pending a Civil Aeronautics Board investigation of the extra fare.

At the same time, Board members voted to permit the carrier to apply the $10 levy to first-class jet accommodations in line with CAB approval of the tariff used last winter by National.

Last year, National added the $10 charge for "de luxe" seats in the front of 707s leased from Pan American World Airways and sold the rear seating as a first class service without a surcharge. CAB instituted an investigation of the first class designation, but before it came to a hearing, National's lease with Pan American expired. National notified the Board that it would change the 707 seating designation, and the inquiry was dropped.

Amount of the coach surcharge was questioned by the Board, which said that it might be unwarranted when compared with surcharges permitted other carriers for similar jet services. CAB pointed out that as a percentage of National's basic coach fare, the surcharge would amount to 18% of the day coach fare, compared with an average of only 9% for other carriers.

Noting that the airline had not justified the amount of the surcharge for coach service, CAB said it would be willing to approve a $5 surcharge as more consistent with the added coach fares permitted other jet operators.

Three Supplementals Lose Operating Rights

Washington—Crackdown on violators of supplemental airline regulations gained momentum last week as the Civil Aeronautics Board ordered revocation of the operating authorities held by three carriers.

Great Lakes Airlines, Currey Air Transport and California Air Charter were charged with intentionally exceeding their 10-trip monthly limitations and with ticketing violations (AW Feb. 2, p. 46).

The Board said that each carrier had continued the violations although CAB compliance attorneys had first warned Great Lakes and Currey five years ago and California Air Charter three years ago.

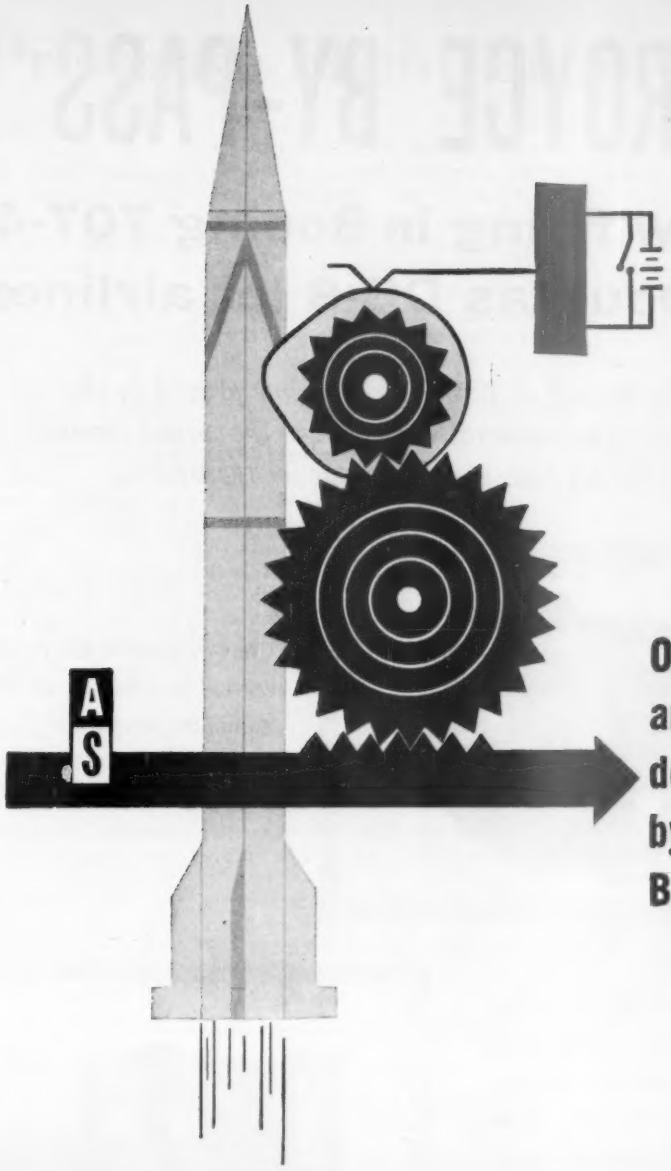
The CAB attorneys said Great Lakes and Currey illegally pooled their trip authorities in order to offer almost daily service on many route segments. At the same time, advertising facilities for the combined service and ticketing facilities were provided by "Skycoach" agencies organized as independent ticketing firms but controlled by the owners and controllers of both supplemental carriers.

An analysis of the carriers' flights during a one-year 1953-54 period disclosed that they provided daily service between New York and Los Angeles except for 66 days, the attorneys said. Similar flight scheduling was offered to Philadelphia and Chicago.

California Air Charter, the Board said, exceeded its 10-trip-a-month allowance by a total of 105 flights during a one-month period in 1956 and a five-month period in 1957. Several flights, considered charter service by the airline, were actually individual services requiring the carrier to charge individual fares as specified in their tariff filings, according to the CAB ruling.

In addition, it said that the airline failed to file copies of many charter agreements for Board approval and leased an aircraft without the required CAB approval.

In reviewing the case, the Board said the carrier recently offered to abide by a cease and desist order with respect to all violations. Rejecting the offer, Board members said a study of the airline's past conduct had convinced them that nothing short of revocation of operating authority would halt the violations.



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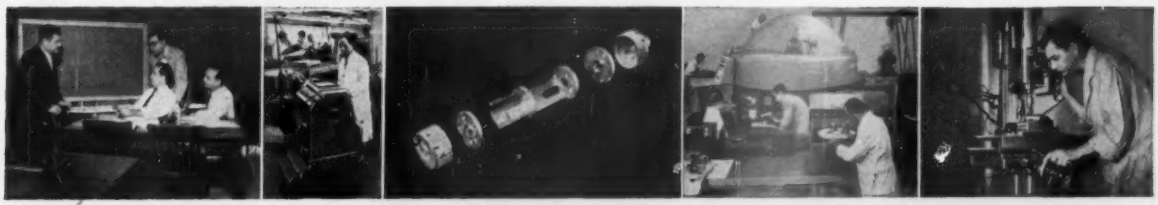

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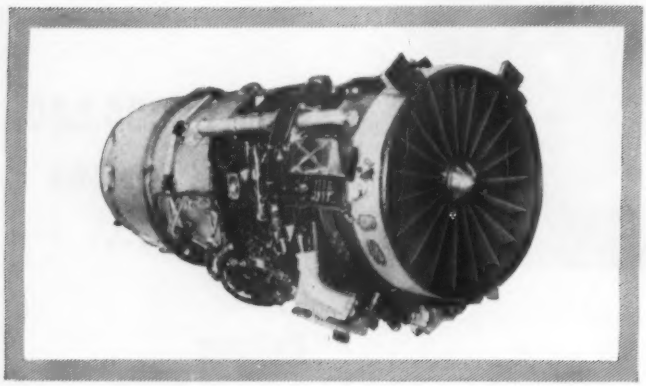

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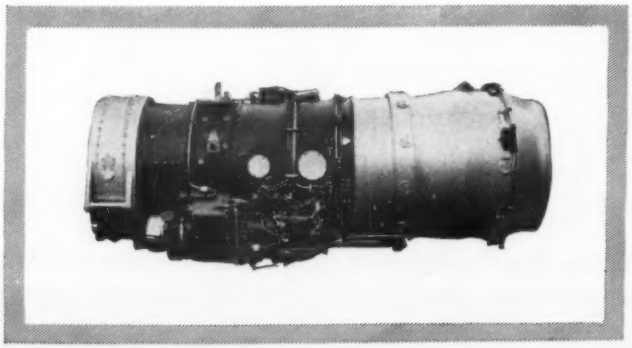

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707's Pre-Crash Flight Data Analyzed

By Glenn Garrison

New York—Flight recorder salvaged from the American Airlines Boeing 707-120 destroyed in a July crash at Peconic, L. I. has provided clues to the final maneuvers of the plane.

However, Civil Aeronautics Board investigators will seek more flight test information to clear up possible areas of ambiguity in the recorder readings.

According to a Boeing analysis of the flight recorder data, the jet transport probably got into a severe right yaw condition about 14 sec. before the fatal crash. A right roll followed and the airplane became inverted. Roll recovery was completed and pullup was initiated just before the impact.

The Boeing reports went into the record of the CAB hearing here last week, the second and final phase in the Board's public hearings on the crash.

First phase was held in August at Riverhead, L. I. near the site of the accident (AW Sept. 7, p. 40).

At last week's hearing, a structures group report found no evidence of malfunction, failure or unairworthy condition.

Testimony at the hearings indicated a last minute application of power was made to engines 3 and 4, believed to have been throttled back in a simulated two engine-out training maneuver. Damage to No. 3 and 4 was more severe than the damage to No. 1 and 2, indicating high rpm. at time of impact.

Certain peculiarities of the particular recorder used during the flight made accurate data reduction extremely difficult, Boeing reported. The instrument records indicated airspeed, pressure altitude, vertical acceleration, heading, and elapsed time. Data reduction difficulties included a missing time trace, intermittent tape transport, skewed tape, incorrect recorder pen spacing, and skewed pen sweep. Further difficulties were experienced from errors external to the recorder, particularly directional gyro gimbal errors, and airplane pitot-static effects during maneuvers.

Boeing's interpretation of the recorder data gives this picture:

The plane had made a low pass over Runway 32 and was completing a go-around approaching Runway 23 in accordance with the specific flight pattern. Altitude was 1,000 ft; airspeed 145-kt. on heading 304 deg. magnetic. At the turn into final approach position, pitch-down maneuver was executed—apparently intentional. This was approximately 14 sec. before the crash.

A severe right yaw developed quickly. Right roll due to yaw followed, and the airplane became inverted 8 sec. after the pitch maneuver. Roll recovery was completed and pullup was initiated just prior to the impact. The airplane magnetic heading at impact was 273 deg. and it was yawed to the left.

A sudden heading change 5 sec. before the crash probably occurred at a bank angle approaching 80 deg. Wings probably were level at impact. Yaw angle at time of rollover was probably greater than 17 deg.

Lockheed Aircraft Service, Inc., which manufactures the model C recorder and Boeing both submitted reports of their analyses of the recorder data. Both believed the final readings to be well within permissible tolerances —i.e. altitude plus or minus 100 ft., airspeed plus or minus 10 kt., acceleration plus or minus 0.2g., heading plus or minus 2 deg.

Their reports reached CAB investigators just before last week's hearing began, Oscar Bakke, the Board's Bureau of Safety director, told AVIATION WEEK.

At the conclusion of the hearing Bakke said some areas of ambiguity might exist in the recorder readings.

"We're dealing with an area in which we have only a very limited experience," Bakke said. The operations group of investigators will go ahead with further studies to gain additional material for analysis. This will include details from all airlines operating the 707 concerning in-flight training incidents they have experienced where students either ran out of rudder or failed to apply rudder, resulting in increased yaw leading to a roll. Speed range involved is about 140-170 kt.

Witnesses at last week's hearing discussed the engine-out performance area, which occupied much of the August phase of the hearings. J. R. Gannett, Boeing senior transition and training pilot, reviewed a recent flight test he made with a 707. With power off engines 3 and 4 he rolled the aircraft left and relaxed pressure on left rudder. The plane yawed right, Gannett said, and rolled into a 20 deg. right bank. He reduced power and applied left rudder and left aileron, effecting recovery. It took about 2 to 3 sec. to recover, and there was practically no altitude loss, Gannett testified.

The Boeing pilot acknowledged that the 707's rudder forces are high and that there have been complaints from operators in this regard. There has been a modification by Boeing since the accident which involves the removal of a rudder feel spring. Purpose of the spring was to provide a constant positive gradient on the rudder pedal force curve in slideslip conditions. But this resulted in high rudder pedal forces in the engine-out condition.

Gannett testified that Boeing has met with various airlines to work out means of performing two-engine-out training to eliminate possible risk. Some airline instructors, Gannett said, may be going to unnecessary extremes in some maneuvers.

FAA Traffic Control Plan

Washington—Federal Aviation Agency is drafting tentative plans to assume command of some 2,095 military air traffic control facilities under a joint military-civilian program designed to provide a unified traffic control system.

The program, which, if implemented, could require an additional 9,000 FAA controllers and 6,000 maintenance technicians over a five-year period, was outlined last week by FAA Administrator Elwood R. Quesada at the fourth annual meeting of the Air Traffic Control Assn. in Oklahoma City. If adopted, Quesada said the program will eventually result in a more efficient use of air space, increased combat capability for the military, improved flight safety and greater economy through a savings in manpower.

Military functions scheduled for transfer to the agency cover flight inspection, flight services, air traffic control training and air traffic control services, with emphasis upon joint military-civil Radar Approach Control centers already in existence.

Quesada said the program cannot be fully implemented until and unless FAA can attain a personnel structure stable enough to guarantee adequate service to the military under all conditions.

As a result, much of the program will remain tentative until the required personnel legislation can be passed by Congress. Under the terms of the Federal Aviation Act, FAA is to submit legislation listing its manpower needs by Jan. 1, 1960. The act also provides the basis for the agency's plan, indicating that it should absorb the bulk of air traffic control functions now being performed by the military.

Recruiting also could be a problem, and Quesada says he intends to incorporate into the proposed legislation greater career inducements to FAA personnel.

Initial manpower needs to get the plan under way include an additional 2,109 positions—393 in training, 1,071 in air traffic management, 545 in facilities and 100 in supporting services.

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Airlines Oppose Mandatory Radar Plan

By Philip J. Klass

Washington—U. S. airlines have voiced strong opposition to a recently proposed Federal Aviation Agency regulation that would require all large passenger-carrying aircraft to be equipped with airborne weather radar (AW July 27, p. 43).

The Air Transport Assn., in its reply last week to FAA's proposed CAR Draft Release 59-10, questions the basic need for a mandatory regulation as well as the terms of the regulation which ATA says could inflict serious operational and economic hardship on the carriers without achieving FAA's intended objective.

The recent FAA action was sparked by a Capital Airlines Viscount turboprop accident near Baltimore in May which appeared to result from the plane entering an area of extreme turbulence with its radar inoperative (AW May 18, p. 41).

ATA Opposition

ATA opposition is surprising in one respect because the U. S. airlines pioneered in the application of airborne radar to weather surveillance and in the development of airline-type weather radar.

Approximately 48% of all the aircraft operated by ATA members are already equipped with radar. The figure is 58% if DC-3s and Lockheed L-18 Lodestars are excluded as presently proposed by the FAA.

This is not, however, the first time the airlines have strenuously objected to changing the status of a system from a voluntary addition to an airworthiness requirement. In the early post-war period, several major airlines exhibited an interest in airborne flight recorders as a means of gathering important operational data. Yet, when the Civil Aeronautics Board first proposed recorders on a mandatory basis, the airlines vigorously opposed the move, although more recently they accepted the requirement for new jet aircraft.

No Cure-All

The ATA reply to the FAA emphasizes that radar can spot turbulence only when it occurs in a thunderstorm where there is precipitation and that severe turbulence found in incipient cumulus and turbulent cumulus clouds gives no warning on a radar scope. One of the most severe gusts encountered in American Airlines early radar tests occurred in a cumulus cloud that gave absolutely no radar echo, ATA said.

Analyzing the 63 incidents and accidents that have occurred since 1950, which FAA cites as justification for its proposed radar regulation, ATA concludes that 40 of them could not have been avoided even if airborne radar had been in use.

Among the 40 incidents, there were 18 in which there was no thunderstorm activity or radar detectable precipitation, according to ATA. In another 10 cases, there was injury to passengers because they ignored the seat belt sign. There were six incidents of hail damage, but radar is not a dependable spotter of hail as both the airlines and military services have found. Hail damage, although expensive to repair, has never been known to cause the loss of an airplane, the ATA said.

Other Factors

Of the 23 incidents which might support the FAA position, ATA says that other factors, such as pilot and dispatcher judgment, also should be considered as contributing to the incident.

The FAA proposal that airborne radar "shall be in operating condition for all IFR operations, and for night VFR operations, when thunderstorms or severe weather conditions are forecast for the flight plan route during the time of flight," could work a serious hardship on airline operations, ATA points out. Unlike all other avionic equipment, weather radar cannot be installed in duplicate because there is not sufficient nose area available for two antennas. Duplicate installations of the transmitter-receiver with a single antenna would involve a considerable weight penalty and would not provide full backup capability.

This means that, if the radar should fail en route or during a stop at a small airport during conditions cited by FAA, the airplane would be grounded there, unless the carriers maintain radar spare parts, test equipment and specialists at each stop. ATA believes that the plane should be allowed to continue to a major maintenance base without an operating radar, assuming that the flight dispatcher and pilot believe weather conditions permit.

The airlines, with an apprehensive eye on the possible application of the regulation to DC-3s and L-18s, say that the speed of the aircraft is a significant factor in determining whether it requires airborne radar. For a high-speed aircraft, which must throttle back and decelerate sharply before entering turbulence, ATA says the advanced warning provided by radar is much more important than for a DC-3 whose turbulence entry speed is much closer to normal cruise speed.

Under the proposed FAA action, the airlines would be required to have their fleets equipped with airborne radars six months after the regulation goes into effect. All of the new turboprop aircraft not now equipped with radar already have the necessary wiring and installation provisions, hence would have little difficulty in meeting the target date. All new turbojets are radar equipped.

The difficulty would occur in retrofitting older piston-engine aircraft which do not have the necessary wiring, brackets, radomes, etc. If the radar installation program were carried out when aircraft come in for regular major maintenance and overhaul, without taking them out of service specifically for the radar installation, ATA estimates that it would require three years for the carriers to retrofit all of their fleets.

Although the radar itself costs around $10,400, ATA estimates that the cost of buying accessory equipment and making the installations would boost the figure to $28,300 per airplane. To this must be added the cost of spare parts and ramp test equipment, which ATA estimates at $15,000 per airplane, bringing the total installed cost to an estimated $43,300 per airplane.

Program Implementation

Implementation of the FAA program also would involve indirect, less tangible costs, including lost revenue due to aircraft out of service for radar installation, disrupted flight schedules due to terminated flights caused by radar failure, additional maintenance personnel for the radar and added radar weight of about 250 lb., corresponding to one additional passenger per aircraft per day.

ATA points out that an across-the-board regulation may prove an unnecessary expenditure for carriers in certain geographical areas. For example, it says that operators in the Alaska-Aleutian area have experienced an average of less than one thunderstorm day per year over the past 20 years, and Hawaiian operators have averaged only eight thunderstorm days per year over the past 10 years. Since radar is only useful for turbulence produced by thunderstorms, such carriers will be able to make little if any use of the equipment, ATA points out, and suggests an exemption for airlines operating in such regions.

ATA concludes its letter to the FAA by urging a major modification of the agency's proposal, or a rescinding of the draft release in its entirety, allowing airlines to proceed with radar implementation on a voluntary basis.

Traffic Conference to Expand Credit Plan

By Katherine Johnsen

Washington—Air Traffic Conference representing over 40 U.S. and Canadian airlines will announce plans this week for a world-wide campaign incorporating leading hotels, motels and car rental agencies into its Universal Air Travel Plan charge account system.

At present, the UATP card, accepted by 113 airlines throughout the world, offers credit exclusively in the air transport field.

In a move toward the expansion, UATP cards are currently being reissued and include, for the first time, the full address of the card holder, enabling persons honoring the card to obtain complete billing information.

Customers will be billed directly, and hotels or other firms honoring the card will not be required to pay any commission, service charge or fees of any kind to the Air Traffic Conference. On the other hand, firms giving the credit will have to withstand any losses that might be involved. Losses on UATP credit thus far has been very low, averaging less than a half of 1%, according to ATC.

Progress Review

A meeting of Air Traffic Conference scheduled for Nov. 17 will review progress on expanding the UATP system to hotels, motels and car rental agencies and at the same time decide whether to extend it still further to stores, restaurants and other facilities as an accommodation to air travelers.

ATC, noting that UATP cards have already been widely accepted as a means of establishing credit, views the planned expansion of the system as "putting on a formal basis what has long been on an informal basis."

UATP's exclusive domain in the air transport field is now being seriously challenged for the first time by other credit systems, notably the Carte Blanche credit card system of the Hilton Credit Corp. and a similar Diners' Club, Inc. plan (AW Sept. 14, p. 40). Pacific Air Lines and Western Air Lines have subscribed to the Hilton system. Western is also accepting Diners' cards, and Pacific is negotiating with Diners'.

Trans World Airlines reports that it is considering the Hilton and Diners' Club plans, as well as other credit proposals that have been proposed.

Attitude of other carriers queried by AVIATION WEEK was to "wait and see" how the industry's own UATP expansion develops before subscribing to another plan which would entail 4 to 12% assessments. A Capital Airlines spokesman said:

"We certainly hope carriers do not join other plans. It would be premature. We are doing a lot with the industry's own plan. We are spending much time and money and are now near the point of announcing new developments."

On the other hand, Arthur F. Kelly, Western vice president-traffic and sales, said that he is "enthusiastically optimistic" over the Hilton and Diners' plans after a few weeks of operation. He said results thus far have been "every bit as well or better than we had hoped."

Ray Costello, Pacific vice president-traffic and sales, which has been using the Hilton plan since July, reports the company "is very happy with the arrangement." Hilton business to Pacific amounted to $4,000 in August, he said.

Kelly told AVIATION WEEK that he contracted with the two credit organizations because he felt UATP does not go far enough in providing passengers with the credit travel conveniences they want and that there is no "fly now, pay later" plan that is concise, simple and without embarrassment to the customer.

Kelly supported the basic UATP plan as a convenience to the businessman. Beyond that, he said he considers it too restrictive to be of any value in the development of new markets. He pointed out that many smaller companies refuse to make the $425 deposit that is required of UATP subscribers. He said that he is convinced that UATP overlooks personal travel that might otherwise be used if it could be charged on a personal basis. The charge for a Hilton card is $6 per year; a Diners' card is $5 a year.

Accounting Factor

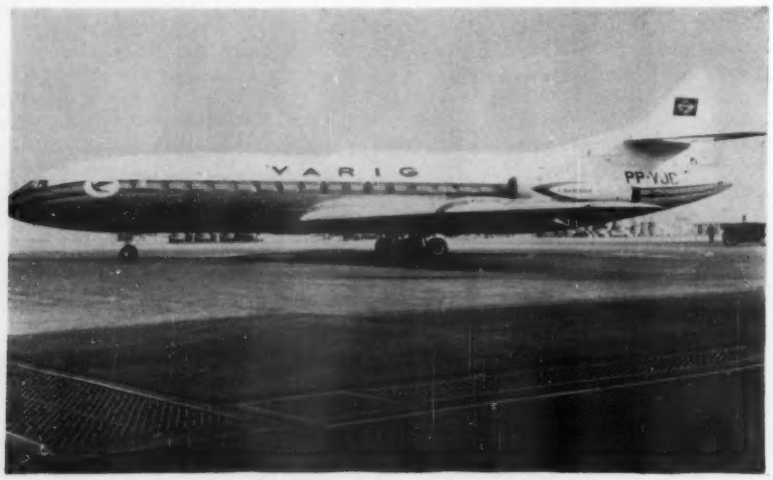
Kelly said that many companies also are reluctant to assume the accounting mechanics of a charge involving their employes' personal travel. The Hilton or Diners' plans, he said, encourage businessmen to use their credit cards for personal, as well as business travel.

Hilton is planning a $1 million advertising campaign to boost its credit cards, part of which will be aimed at use of the cards for service on Western or other carriers that subscribe to the plan. Hilton charges Western 4% for the business generated through its cards. The charge for Diners' service is more than double this.

ATC concedes that UATP is primarily directed toward businessmen traveling on expense accounts. One firm, making the $425 deposit, can issue an indefinite number of UATP cards to its employes. Under the expansion plan, employes will be billed separately for expenses they incur at hotels, motels or car rental agencies. ATC does not believe that the $425 deposit discourages individuals who travel frequently from subscribing to its plan.

Meanwhile, individual airlines have taken steps to improve charge account service on their systems. They include:

• **On-Line Credit Card.** Northwest Airlines has put this plan, which resembles the industry-wide UATP, into operation. The on-line cards are good over Northwest's domestic system, including Hawaii and Alaska, but cannot be used for interline travel or on other carriers.



Varig Takes First Jet Delivery

Ready to start New York-Brazil jet runs in December, Varig Airlines accepted its first Sud Aviation Caravelle in Paris recently, with a second to follow in December.

No deposit is required. On-line cards are issued to individuals, groups or companies after a check of their credit rating. Tourist agents are paid their regular commission if they issue tickets to an on-line credit card holder.

• **Write-your-own ticket plans.** These plans, aimed at saving the holder of a UATP card the bother of checking at ticket counters, have or are being put into effect by at least three carriers. A number of others are expected to follow suit. Here, the passenger makes his reservation, writes out his own ticket, hands the ticket and his baggage to the agent at the airport and boards his flight.

The Northwest plan known as "Simplex" has been in operation for the past few months. "Simplex" books of 10 tickets are issued to holders of Northwest on-line credit cards, as well as holders of UATP cards, and can be used over all points on Northwest's domestic system including Honolulu and Anchorage.

'Air Check' Plan

American Airlines is now in the process of putting into effect its "air check" plan. The "air check" tickets may be made out to any point on American's system. The plan already has proved successful over American's Washington-New York-Boston segment.

After two months of successful operation with Chicago-Minneapolis ticket books, Capital Airlines this week will announce a plan to issue "multi-destination" ticket books. These tickets may be used for transportation between nine points on Capital's system—Atlanta, Buffalo, Cleveland, Chicago, Detroit, Minneapolis-St. Paul, New York, Pittsburgh and Washington.

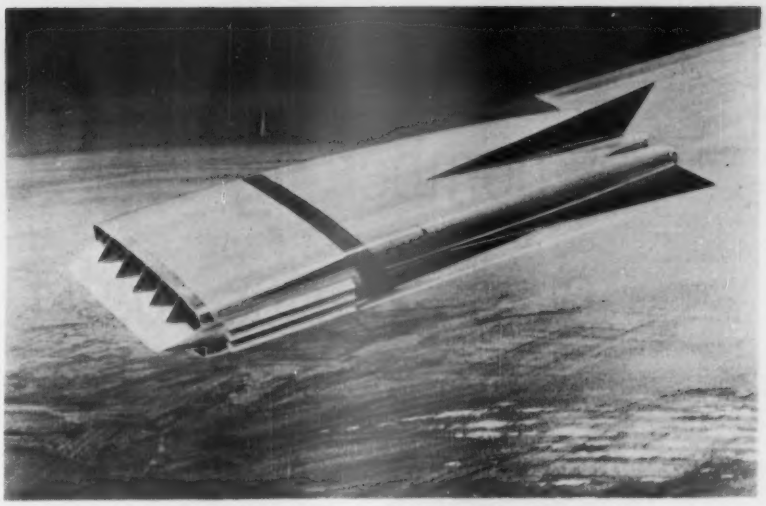
Middle East Airlines, BOAC Strengthen Ties

London—British Overseas Airways Corp., will retain its 49% holding in Middle East Airlines. The two companies also are planning to draw closer together, according to a joint statement made at the end of negotiations.

Both operators are seeking an agreement after rejecting plans submitted by the other.

One proposal, from Middle East Airlines, was that MEA should buy BOAC's interest for about $1 million.

The two now have agreed that BOAC will retain its interest and that each airline will "contribute materially to the success of the other." A joint working committee will be formed to study ways of "coordinating development of air services and integration of various common services," the airlines said in their statement.



SUPERSONIC TRANSPORT described by Hall L. Hibbard, Lockheed senior vice president, would travel at 4,700 mph. Deflected airflow would permit VTOL operations.

Lockheed Studies Mach 3 Vehicle As Next Step in Transport Field

Delft, Holland—Jet transports with cruise speeds above Mach 5 will have attractive commercial potential, Dr. Hall Hibbard, Lockheed vice president, predicted in delivering the Dr. Albert Plesman memorial lecture here last week.

The next step in commercial transport will, however, be in the somewhat more conservative speed range between Mach 3 and Mach 3.5, Hibbard said, and estimated that such a transport could be operational in 1965.

He did not say how far Lockheed had gone with studies on such an aircraft but listeners with long memories remembered that Hibbard had talked about the airlines' need for a "bigger and better Viscount" not too long before the company announced the development of the Electra turboprop transport.

Ramjets Possible

Powerplants for the Mach 3 range will be conventional turbojet engines; those for higher supersonic range will be turbo-ramjet units or possibly pure ramjets.

Lockheed had made design studies of two basic types of supersonic transports, he added. One of these was designed to cruise just above Mach 2, at the limits of conventional aluminum alloy structure. The other was designed for Mach 3-3.5 speeds and was built around a steel and titanium structure.

Hibbard said that direct operating costs of the faster aircraft turned out to be the lower of the two, in spite of the increased cost of construction and development of the type. Growth potential and the much improved block speed of the faster aircraft has stopped Lockheed consideration of any more designs with cruising speeds less than Mach 3.

One basis for company confidence in its design work is the immense amount of supersonic flying time being racked up daily.

Hibbard estimated that USAF and Navy aircraft were logging about 1,000 supersonic flight hours per day, and with the rest of the free world putting on about 400 hours per day of supersonic time, yearly totals are around the half-million hour mark.

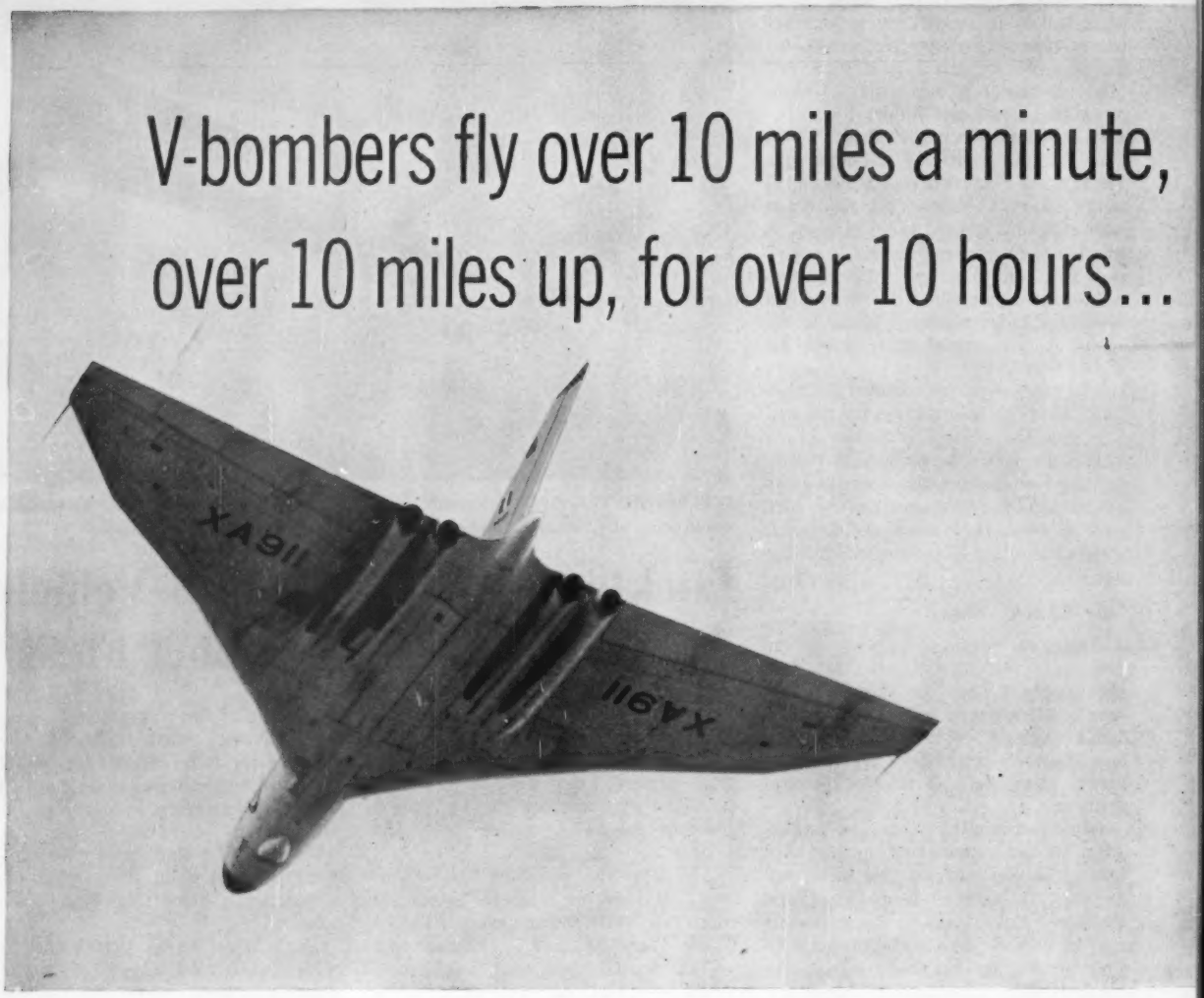
Useful Payload

Hibbard said that company design studies showed an inefficient flight regime for a 3,500 naut. mi. range at speeds between Mach 0.9 and 1.5. Magnitude of useful payload in increases again at about 3.5 because of turbojet limitations.

Above Mach 3.5, he said, dual-cycle powerplants begin to look good but not commercially attractive in the near future.

Using estimated ramjet performance figures based on a 1970 state of the art, studies show that payload potentials at Mach 5 are of the same order of magnitude as those experienced today in subsonic transports. Lockheed's design studies have gone into the Mach 7 range and have covered winged and wingless VTOL types on a design range of 3,500 naut. mi. with necessary reserves.

V-bombers fly over 10 miles a minute, over 10 miles up, for over 10 hours...



...AND BRISTOL SIDDELEY

One of the largest manufacturers of motive power units in the world, Bristol Siddeley Engines Limited produce two outstanding high-thrust turbojet engines—the Olympus and the Sapphire.

Between them these two engines power the major part of the RAF's strategic V-bomber fleet. Olympus engines, delivering up to 17,000-lb thrust dry (other versions will produce as much as 33,000 lb), power the Avro Vulcan Mk 1 and 2. Sapphires power the Handley Page Victor Mk 1. These engines give the V-bombers supersonic capability—long range—great altitude—superior performance to any other aircraft of their type in the world.

BRISTOL SIDDELEY ENGINES LIMITED

SUPPLY THE POWER

The Bristol Siddeley Proteus powers the Britannia airliner. Four Proteus give this 130-seat aeroplane a speed of over 400 mph—a range of over 5,000 miles. Britannias are in service with twelve airlines and with RAF Transport Command.

The Star Sapphire car is powered by a Bristol Siddeley 4-litre engine. Combining great power with exceptional quietness and luxurious comfort, the new Star Sapphire has a top speed of over 100 mph and an outstanding all-round performance.

Bristol Siddeley Viper turbojets range from 1,640—3,000-lb thrust. Vipers power the Australian Jindivik, the Hunting Jet Provost, the Italian Macchi MB 326 (illustrated), and have proved their supersonic capabilities in mixed powerplant fighters.

AIRLINE OBSERVER

▶ Watch for Federal Aviation Agency to begin an experimental helicopter operation between major Eastern cities in an effort to unravel the mounting problem of helicopter integration into air traffic control patterns. Operation probably will be on an around-the-clock, all-weather basis.

▶ Also look for public hearings on Federal Aviation Agency's proposals to set a mandatory retirement age and cut off date for jet training of airline pilots (AW Oct. 5, p. 36). Key issue is an FAA proposal to limit jet transition training to pilots under 55 years of age. Both the Air Line Pilots Assn. and carrier managements have pushed for a hearing on grounds that the proposal has no factual bearing on in-flight safety and would only result in heavy financial losses to both pilots and the airlines.

▶ Craig Timmerman, head of Air Transport Assn.'s air navigation and traffic control group will leave within the near future to join General Precision Laboratory as part of the company's effort to expand its know-how in airline operations and traffic control. Timmerman is the third member of ATA's technical staff to shift to GPL in the last two years.

▶ Federal Aviation Agency is expanding the training of its flight test pilot engineers by sending them to Air Force and Navy test pilot schools. Shortage of pilots with engineering degrees was cited by the agency as the reason behind the cooperative program. Pilots attending the military schools must have a minimum of 1,500 hr. in various aircraft and be trained in higher mathematics, physics and the theory of flight. Air Force courses are for four months, Navy's for nine.

▶ Boeing Airplane Co., expects to aid airline training programs by sending a traveling team of experimental test pilots to airline training schools for instructor pilot indoctrination. Team will first visit Pan American World Airways at San Francisco to facilitate transition training for the intercontinental Boeing 707-320. Factory pilots will later visit Lufthansa, British Overseas Airways Corp., Sabena, Air France and Air India.

▶ Northwest Orient Airlines is accelerating its study of the Minneapolis Honeywell-Atkins Maximum Safety Light following recent FAA certification of the airborne light designed to reduce the midair collision hazard. Flashing strobe light system developed by Northwest pilot H. W. Atkins in conjunction with the Minneapolis-Honeywell Corp. has now undergone more than 1,400 hr. of flight testing on a Douglas DC-6B flying scheduled service over most of the airline's routes. Manufacturer's preliminary cost figures have been submitted to Northwest, which will continue the flight evaluation to obtain further pilot comment and data.

▶ Civilian aircraft within the U. S. may exceed the 100,000 mark by the end of this year, according to Federal Aviation Agency statistics. Total of 98,893 civil planes were registered with FAA at the first of the year, and the agency predicts that a total of 100 jet airliners and 250 turboprop transports will be in service by the end of the year. Planes registered include 97,598 fixed-wing aircraft, of which 87,535 are single-engine planes; 700 helicopters, 10 autogiros, 6 dirigibles, 542 gliders and 37 balloons.

▶ Scandinavian Airlines System has picked up an option for an additional Caravelle jet transport, raising its total order for the Sud Aviation aircraft to 17, four of which were ordered by SAS for Swissair under a joint equipment purchase agreement between the two carriers. SAS also hold options on eight other Caravelles.

▶ Afghanistan has opened its new Kabul airport to jet transport traffic, with the first landing being made by an Aeroflot Tu-104.

▶ Pan American World Airways last week declared its third cash dividend for 1959. Directors of the company voted a dividend of 20 cents a share payable Nov. 13. Dividends in the same amount were paid in February, May and August of this year.

SHORTLINES

▶ **Air France** reports that it carried 23,562 eastbound passengers on its North Atlantic routes during the first six months of 1959 for a 15.9% increase over the same half year period of 1958. Revenues on the routes increased 11% during the same period. Economy and tourist class accounted for almost 75% of the passenger figure while de luxe and first class represented the rest.

▶ **American Airlines** airlifted the entire home office of National Telefilm Associates, Inc., from New York to the television company's new headquarters in Los Angeles during the weekend of Sept. 25-28. The airline transported all office furniture in two chartered Douglas DC-6A airfreighters plus 60 adults and 29 children on a scheduled Boeing 707 New York-Los Angeles flight. Equipment moved included approximately 151 desks, 75 business machines, typewriters, adding machines and calculators; 12 tons of promotional material, and 450 files. The entire operation required less than 72 hr. so that NTA personnel left their New York desks on Friday evening and sat down at them in Los Angeles on Monday morning.

▶ **Frederick B. Ayer & Associates** has reduced the price of 16 Convair 240 aircraft by $50,000 each. Ayer contracted to purchase the aircraft from American Airlines when American began to retire them from service. The passenger Convair 240 airliner will now sell for $200,000, while a custom designed executive version of the aircraft will sell for $335,000.

▶ **Garrett Corp.'s** AiResearch Aviation Service Division, Los Angeles, has been designated an authorized repair station and spare parts dealer for all models of the Fairchild F-27 turboprop transport. AiResearch will provide facilities for repair, overhaul, modification and servicing for the aircraft.

▶ **Skyways, Ltd.**, a British independent airline, has placed a letter of intent with Hawker Siddeley for three Avro 748 aircraft.

▶ **United Air Lines** began the first direct air express service from California to Hawaii on Oct. 7. Express shipments will be carried on all United flights from both Los Angeles and San Francisco to Honolulu. The rate for a five pound shipment is $5.93, while a 25 lb. shipment is carried for $21.65. United has carried both air mail and freight on the California-Hawaii route since inauguration of passenger service in 1957.

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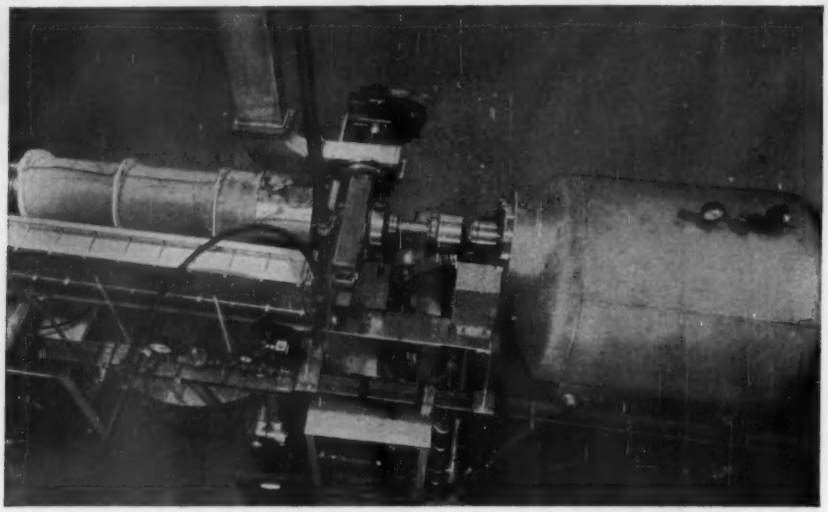

The ARCO L-band accelerator may be seen in actual operation at ARCO's Walnut Creek, California plant. Come and see it perform.

A new theoretical concept, developed by ARCO physicists, now proved beyond question.

First use of the lower L-band frequencies; higher power at lower cost.

A sweeping redesign of accelerating waveguide structures, radical with respect to conventional approaches.

Dependable Litton Industries L-band klystrons and other high-reliability production model components.

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A major advantage of the new machine is that it is not subject to the limitations (such as pulse shortening) in peak and average beam power levels that have plagued performance of earlier machines. Pulse shortening above the 4 kw level has been eliminated, despite output many times that of previous linacs. Performance of the new L-band machine shows that high power can be obtained even at energies up to 80 Mev.

Purchasers and engineers who have inspected the new ARCO machine believe it will usher in a completely new era in research and processing.

In research, the ARCO L-band machine makes possible exotic physics experiments such as neutron time-of-flight studies using flight paths up to ¼ mile in length. It greatly extends the range of experiments possible in single pulse radiation effects studies. It also permits measurement of transient effects in neutron multiplying assemblies.

In industrial processing, the higher performance and corresponding reduction in cost per kw-hr. are expected to make practical many applications which have looked promising in the laboratory but have been ruled out by high operating costs. Examples are polymerization processes, reforming of petroleum fractions, modification of polymers as in cross-linking, grafting and vulcanizing and commercial production of isotopes.

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6053

Blue Steel Missile Starts Flight Tests

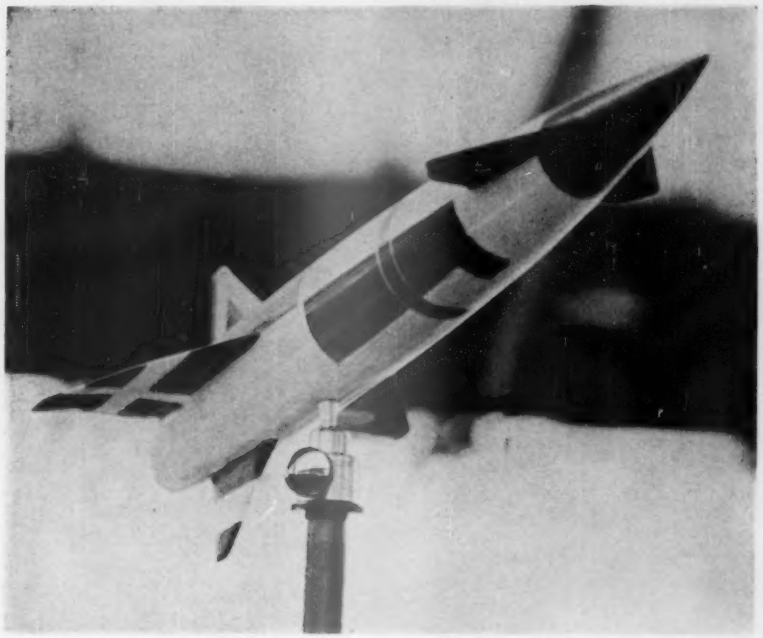
By David A. Anderton

Farnborough—Systems and components for the Avro Blue Steel air-to-surface missile are now being flight-tested in full-scale vehicles.

Rocket-powered by a de Havilland Double Spectre engine and using an inertial navigation system developed by Elliott Brothers, Blue Steel is a canard layout about 36 ft. long. Concept and appearance are similar to those of the Bell Rascal now out of production and in service with the USAF.

Production contract for Blue Steel is not yet confirmed, and so far only test vehicles have been produced by the Weapons Division of A. V. Roe and Co., Ltd.

Present phase of the test program follows earlier firings of free-flight models on the Royal Aircraft Establishment range at Aberporth, Wales. Flight tests have been made with large-scale models dropped from Vickers Valiant bombers over the range at Woomera, Australia, and at an unspecified range in the United Kingdom.



CURRENT CONFIGURATION of Blue Steel air-to-surface missile is shown by this model painted red and white in geometric pattern to aid optical and photographic tracking. Wingtips have noticeable anhedral to clear tailpipes of mother airplane. Forward control surfaces are trapezoidal, with clipped tips suggesting a design speed on the order of Mach 2. Fuselage sections are circular to leading edge of wing, then change to elliptical to house de Havilland Double Spectre rocket engine whose two thrust chambers are arranged in over-and-under fashion (AW Aug. 25, 1959, p. 25).

Mission Concept

Basic mission of the Blue Steel is the same as any other air-to-surface missile: Extend the safe striking range of a manned bomber. Blue Steel is designed as part of the weapons load for the Avro Vulcan and Handley-Page Victor bombers. It is carried in a special mounting in the bomb bays, but most of the missile is outside the bay itself. It is possible that the mounting extends the missile below the belly of the aircraft just before launching.

At launching, the missile is dropped clear of the plane and falls freely for a few seconds. The rocket powerplant is fired and the missile accelerates in level flight to design speed, perhaps on the order of Mach 2. Flight path is programed and after acceleration phase, the missile trades speed for altitude, climbing to its maximum height.

Details of the flight path have not been revealed, but it is probable that the missile pitches over into its final dive onto the target right after completing its climb to altitude. This makes it in effect a powered toss-bomb, and increases the range over the figure that would be obtained if the dive followed a level-flight cruise.

Structure of Blue Steel is conventional but special construction has been provided to handle the heating problems, the company says. These must occur in the terminal dive to the target, because level-flight speed of the Blue Steel would not be high enough to give serious trouble from aerodynamic heating.

There is also a possibility that the warhead separates for ballistic fall, as in the case of the Northrop Snark cruise missile, in order to give ground radars a smaller target and lessen the likelihood of interception by an anti-missile missile.

Blue Steel uses the "twist-and-steer" principles. This means that turns are made by first rolling the vehicle with the ailerons and then increasing lift on the vehicle to maintain the turn, reducing it to come out and rolling back to level flight again.

First glimpses of the configuration were provided at last year's Farnborough display, when an Avro Vulcan flew past carrying a bright yellow Blue Steel, either a full scale model or a test vehicle (AW Sept. 8, 1958, p. 26). Avro also showed a model of the Vulcan carrier with the Blue Steel in place and a control test vehicle, both differing in detail from the current "final" layout.

Avro was hoping to get permission from the Ministry of Supply to show a complete Blue Steel vehicle at this year's SBAC display, but this was denied. Only appearances of the missile were in model form, once as one of a group of tiny configuration study models on the Hawker Siddeley stand and again as a small model on the de Havilland stand. The de Havilland model was painted with the red-and-white geometric markings which aid optical and photographic tracking of the real missile.

Wingtip Anhedral

Only change from a conventional canard layout is that the wingtips have a pronounced anhedral, presumably to clear the tailpipes of the carrying planes.

Powerplant for early version of the Blue Steel missile is the de Havilland Double Spectre D.Sp.1, with a full-thrust rating of 16,000 lb. from its two-barrel engine. This engine has been under development for two years as a basic powerplant for missiles and piloted interceptors; one of its intended

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Short Seacat on Launcher

Four Short Seacat short range anti-aircraft missiles for the Royal Navy are shown mounted on a typical launcher at the 20th SBAC display at Farnborough. Launcher was developed by Rose Brothers (Gainsborough), Ltd., under a British Admiralty contract, although design has not yet been adopted for the missile. Seacat is powered by a solid-propellant rocket engine and is designed to be instantly available for action. Layout suggests that missile has movable wings and fixed fins. Guidance system is unspecified. Missile is intended to replace 40-mm. anti-aircraft cannon which has high rate of fire; guidance system would have to be able to cope with barrage fire of these missiles in order to give an over-all weapons effectiveness not below that of 40-mm. fire. This would seem to rule out most conventional systems of guidance; only clue to Seacat system is statement by First Lord of the Admiralty that it has a "novel type of direction." Announcement of development contract for Seacat was made in April, 1958. Short had shown SX-A5 test vehicle for Seacat on its stands at Farnborough in 1957 and 1958; first showing of Seacat configuration was at the Paris air show. Company is working on a land-based version to be called Tigercat.

uses was as the rocket engine for the ill-fated Saunders-Roe line of mixed-powerplant interceptors.

The Double Spectre consists of two individual rocket engines: a fixed-thrust Spectre 4, similar to those produced as assisted-takeoff units, and a variable-thrust Spectre 5. Over-all length of the engine is 58.6 in., height is 39.0 in. and width is 37.5 in.

Placards on the de Havilland stand labeling the Double Spectre were careful to state that the engine was used on "the first" versions of Blue Steel. Later versions—presumably production missiles—will have a different rocket engine, not of the de Havilland design.

A logical switch would be to the Bristol Siddeley Gamma engine, a four barrel unit now used to power the Black Knight re-entry test vehicle.

Gamma has a thrust rating of 16,400 lb. which increases to about 19,000 at very high altitudes. Dimensions of the Gamma show it to be somewhat smaller than the Double Spectre for the same thrust, although it does have double the number of component parts. Gamma over-all length is 38 in., and diameter of the unit is 36 in.

Both engines operate on kerosene as fuel and concentrated hydrogen peroxide as oxidizer.

Inertial navigation system for the Blue Steel missile is being developed by Elliott Brothers, Ltd., of London. The company displayed a diorama of a typical sequence for the missile and one of its carriers, the Avro Vulcan B Mk. 2, at the SBCA display. Operation of the system was divided into four phases:

- **Standby,** with airplane and missile on the ground in alert status. The inertial system is set up and operating, and is being checked by ground equipment.
- **Captive,** with the missile airborne by its carrier. During this phase, the inertial navigation system is being monitored by equipment in the mother airplane, and by feedback improves the navigation of the airplane.
- **Release,** with the missile dropped free and starting its own powered flight phase. Just before drop, the aircraft navigational system feeds the final position data to the missile system. After release, the missile is on its own and the airplane pulls out of the run-in.
- **Free-flight,** with the missile in cruise condition. The Blue steel is programed to accelerate in level flight at an altitude below release, and then to trade speed for altitude in a zoom climb to its operating height, which has been reported as 60,000 ft.

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Frequency (cps)	400	400
Primary Imped.	400/80°	8500/80°
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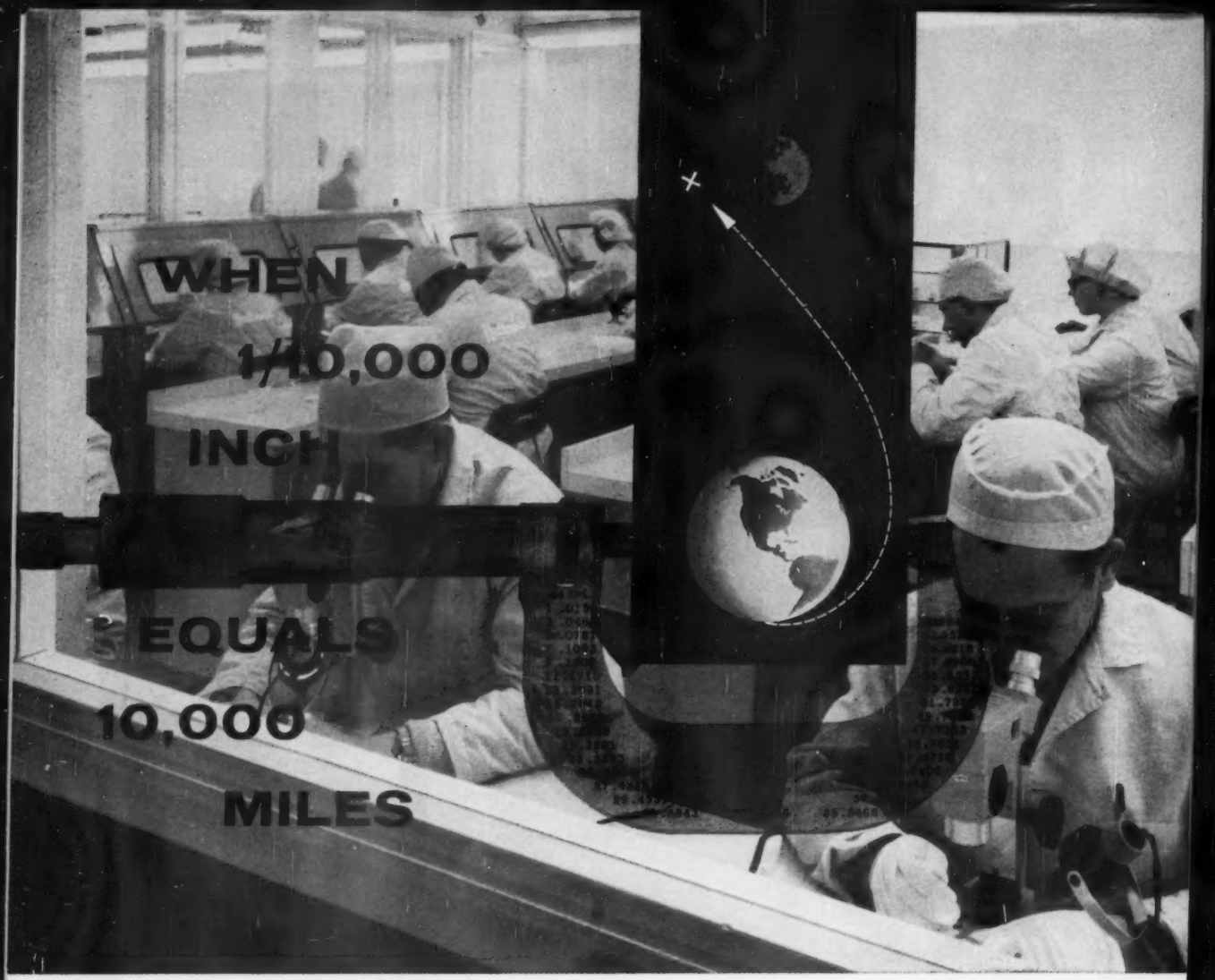

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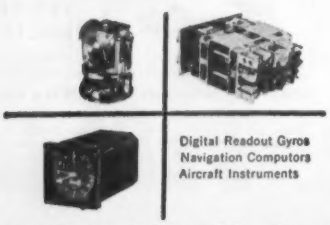

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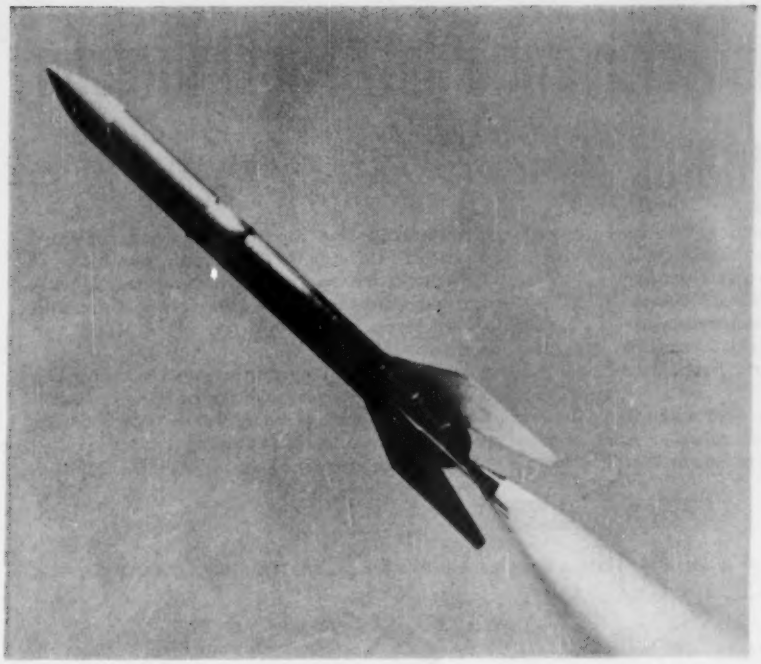

EXPERIMENT, INC. TR-1 steam rocket, shown here in an evaluation flight from Wallops Island, is proposed as a low cost, meteorological research vehicle.

Water May Have Rocket Power Use

New York—Drawn by the economic attractiveness of tap water as a rocket propellant, scientists are continuing their efforts to develop practical steam and hot water propulsion devices.

Currently suggested applications for such devices run all the way from primary propulsion sources to retrorockets and auxiliary propulsion units. Among the U.S. groups reported to be interested in or working on such devices are Experiment, Inc., Hughes Aircraft, Applied Physics Laboratory at Johns Hopkins University, Martin Co. and North American Aviation.

At present, actual hardware is limited to a small, inexpensive hot water rocket being offered by Experiment, Inc.

Aimed primarily at an amateur and educational market, this vehicle sells for $225 without launcher and could find application as a low cost, low performance weather research rocket.

Hypothetical Application

A more interesting but still hypothetical application is the use of a hot water rocket in a re-entry vehicle, suggested by Walter Kuehnegger of the Martin Co. Aerodynamic heat of reentry would be used to raise the temperature of water contained between the inner and outer shells of the vehicle.

The hot water, which in the process would also serve as a coolant, would then be vented through nozzles to act as a retrorocket and produce thrust.

The use of hot water rockets as aircraft RATO (rocket-assisted takeoff) units is another suggested application. In Germany, Eugen Sänger is believed to be pursuing the development of a large hot water booster rocket of many thousand pounds thrust. In this country, a number of scientists have expressed interest in small units of this type as auxiliary power units or auxiliary thrust devices which might be used for attitude control or possible orbital correction.

Low Cost

In all these applications, the principal attraction of the water rocket is its extremely low cost. Regular tap water can serve as the propellant and it can be heated by electricity or, in the case of the Experiment, Inc., rocket, by a simple butane gas heater. No involved ground handling equipment or special precautions are required. For the smaller auxiliary power unit type of device, it has even been suggested that the astronaut's urine might serve as the propellant.

On the other hand, the low cost of these water propulsion units must be paid for in performance. Specific impulse of the hot water propulsion system ranges approximately from 45 to

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Analog-to-Digital Converters

Kearfott's rugged shaft position-to-digital converters are resistant to high shock and vibration and high and low temperature environments. Ideally suited for missile applications, these converters are available for many uses, including latitude, longitude, azimuth or conventional angular shaft displacement conversion and decimal count conversion. Exclusive drum design provides large conversion capacity in smallest size. Combination counter converter assemblies for both visual and electrical readout also available.

TYPICAL CHARACTERISTICS

Kearfott Unit No.	P1241-11A
Code	Cyclic Binary
Range	0-32,768 (2^{15})
Bits per Revolution	16
Revolutions for Total Range	2,048
Volts D.C.	10.5
Current (ma.)	20
Inertia (gm. cm.^{2})	20
Unit Diameter (in.)	1¾
Unit Length (in.)	3
Life	10^6 Revolutions or 10^3 hours
Static Torque (in.-oz.)	2 (break) 1 (running)
Weight (oz.)	5
Maximum Speed (RPM)	600

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TCA orders Collins Automatic Pilot/Flight Director for new Vanguards

Trans-Canada Air Lines high density inter-city routes will soon be served by the new turbo-prop Vickers Vanguards as part of TCA's growth toward the first all-turbine intercontinental fleet. TCA selected the world's most advanced performance automatic flight control systems for the high performance Vanguard – Collins AP-103 Automatic Pilot and FD-105 Integrated Flight System.

Smooth three-axis control of attitude and navigational situations, from take-off to touch-down, are effected in this minimum weight, transient free system, preserving the motion-free comfort the Vanguard will provide for its 96 passengers.

Other Collins "Airline Standard" systems for the TCA Vanguard include VHF communication and navigation systems, glideslope receivers, ADF, and system antennas.

Collins flight control systems, now serving the TCA Viscount fleet, will provide flight director services on all-jet DC-8's soon to be added on TCA's transcontinental and trans-Atlantic flights.

Write Collins for literature on the AP-103/FD-105.

COLLINS

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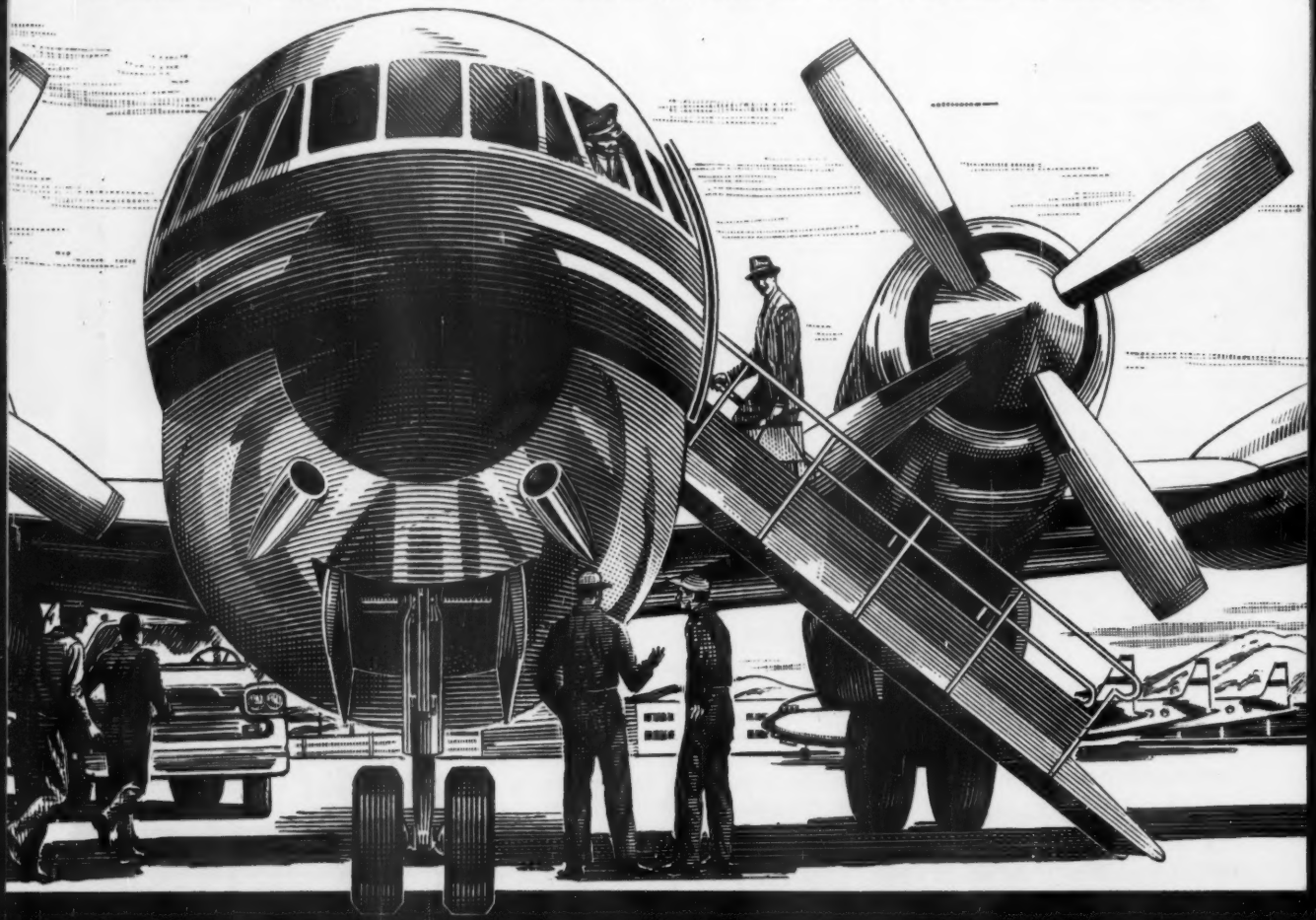

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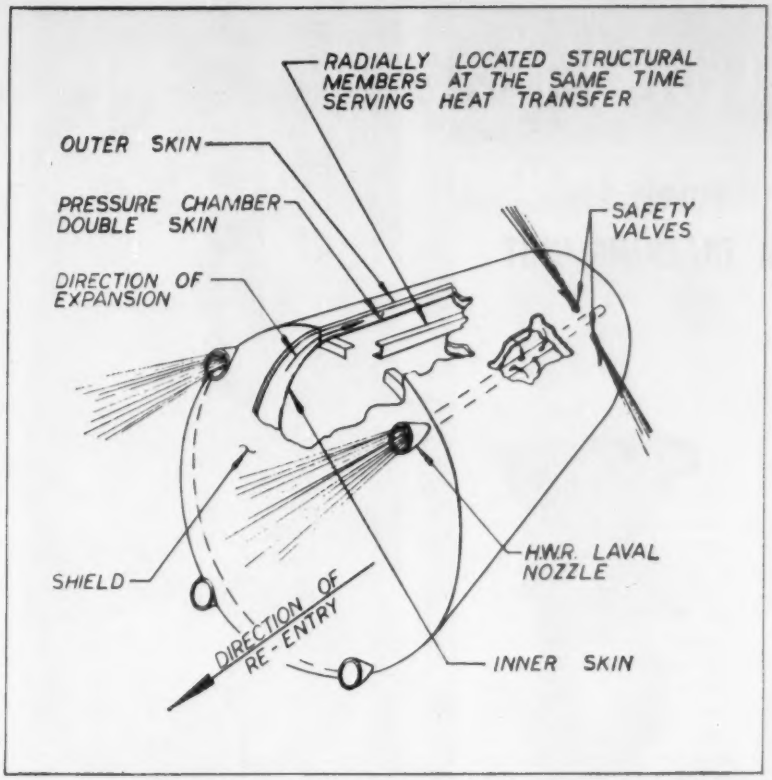

WATER contained between inner and outer skins of a re-entry vehicle, suggested by Martin Co.'s Walter Kuehnegger, would double as a coolant by absorbing aerodynamic heating before being vented through the retrorocket nozzles.

60 sec. Substitution of straight steam might double specific impulse and put steam in the energy category of monopropellants such as hydrogen peroxide.

At a recent American Rocket Society meeting (AW July 27, p. 30), engineers Denis Zigrang of the Martin Co. and Arthur Widawsky of North American Aviation, Inc., computed a typical steam rocket performance at 121.6 sec. In general, they felt that steam's higher specific impulse made it more desirable than hot water. For some applications, such as aircraft RATO use, steam's low density is objectionable and the hot water rocket appears preferable.

Experiment, Inc.'s, TR-1 steam rocket, named after Capt. Robert Truax, USN (Ret.) who is credited with the idea for the rocket, is essentially a hot water rocket with some steam pressure formed above the water. The TR-1 operates at a pressure of 500 psi. and a temperature of 470F. Specific impulse of the system is approximately 45 sec. If all the water in the rocket were superheated steam, Experiment, Inc.'s, Jerry Burke says it would be possible to get a specific impulse of about 121 sec.

The rocket stands 6 ft. 8 in. high, is 5.5 in. in diameter, weighs 17.5 lb. empty, and will hold 30 lb. of water and another 30 lb. in payload. Launcher is a 4-ft.-long cylinder plus stand which costs $275. There are three gas burners located on the launcher to which are attached the butane bottles used to heat the rocket.

Theoretically, the TR-1 should be able to reach an altitude of 10,000 ft. Earlier this year, two of the rockets were fired at Wallops Island under the sponsorship of the Office of Naval Research, which is interested in low cost rockets for possible use in meteorological research. The rockets, however, weather-cocked into the wind and reached an altitude of about 3,000 ft.

Altitude Capability

Experiment, Inc., is currently working on the improvement of the TR-1's altitude capability and tendency to weather-cock.

One officer of Naval Research Office, however, believes steam rockets will have a hard time competing with conventional rockets. Economy, he says, will have to be the most important factor. But economy is what Experiment, Inc., and the other steam advocates are counting on to sell their vehicles and ideas. For a small additional cost, for example, the TR-1 can be equipped for parachute recovery, in which case it is estimated that the rocket can be fired for as little as $50 a shot.

BASIC BUILDING BLOCKS FROM KEARFOTT

Integrating Tachometers

Kearfott integrating tachometers, special types of rate generators, are almost invariably provided integrally coupled to a motor. They feature tachometer generators of high output-to-null ratio and are temperature stabilized or compensated for highest accuracy integration and rate computation. Linearity of these compact, lightweight tachometers ranges as low as .01% and is usually better than ± .1%.

TYPICAL CHARACTERISTICS

	Size 11 (R860)
Excitation Voltage (400 cps)	115
Volts at 0 rpm (RMS)	.020
Volts at 1000 rpm (RMS)	2.75
Phase shift at 3600 rpm	0°
Linearity at 0-3600 rpm	.07
Operating Temperature Range	−54° +125°

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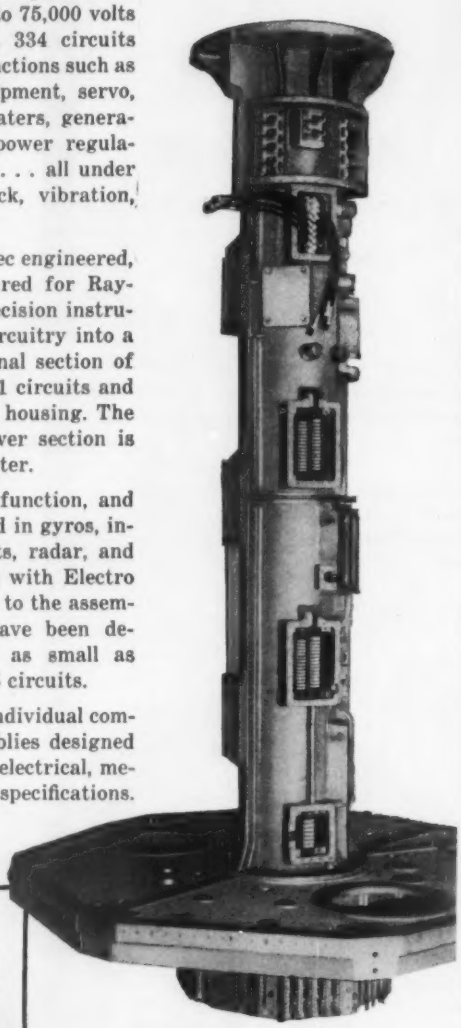
critical slip ring assembly for TARTAR MISSILE RADAR TRACKING UNIT

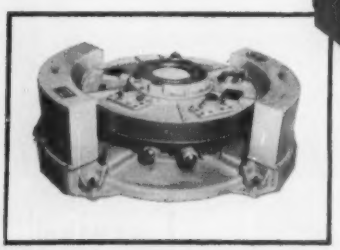
THE PROBLEM — Means was required for the uninterrupted transmission of power and signals through a rotating joint to a revolving antenna. Power requirements were extremely high — up to 75,000 volts — and space was limited. 334 circuits were involved in diverse functions such as operating TV camera equipment, servo, and synchro equipment, heaters, generators, de-icing equipment, power regulators, and hydraulic pumps . . . all under extreme conditions of shock, vibration, and humidity.

THE SOLUTION — Electro Tec engineered, prototyped, and manufactured for Raytheon a highly sensitive precision instrument that packs a lot of circuitry into a small unit volume. The signal section of the slip ring consists of 331 circuits and is 6 feet tall complete with housing. The base which houses the power section is 3 feet tall and 52" in diameter.

Many other unique space, function, and reliability problems involved in gyros, inertial guidance, instruments, radar, and switching have been solved with Electro Tec slip rings.* In contrast to the assembly for Raytheon, units have been designed and manufactured as small as .039" diameter containing 6 circuits.

Write for information on individual components or complete assemblies designed to meet the most stringent electrical, mechanical and environmental specifications.





*Patent No. 2,696,570 and other patents pending.

Write Electro Tec Corporation on all your slip ring requirements.

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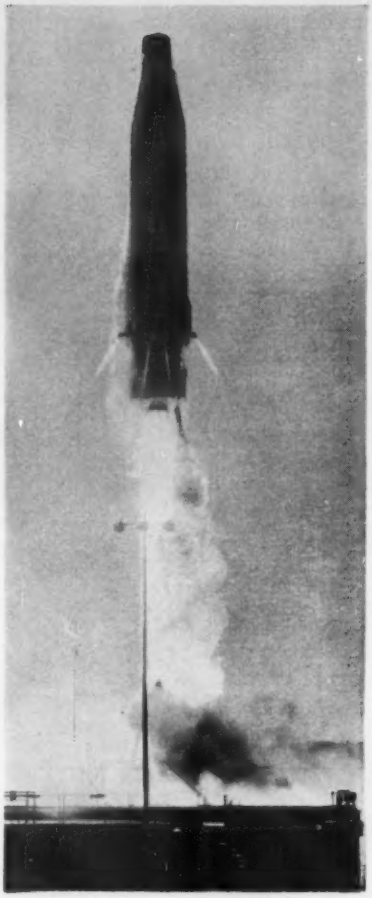


SAC Atlas Shot

Atlas intercontinental ballistic missile lifts off the pad in first all-military crew firing by Strategic Air Command (AW Sept. 14, p. 32) at Vandenberg AFB, Calif.

Overcharge Reported On Air Force Contract

Washington – General Accounting Office has reported over-charges totaling $240,000 by Rheem Manufacturing Co. on a $1.3 million Air Force fixed-price contract for MB-4 practice bombs and related items.

After determining that its profits were higher than anticipated, Rheem voluntarily offset these by accepting a loss of $179,000 on a follow-on contract, obtained on an advertised bid, GAO said. Average net profit on the two contracts was estimated at 12.2%.

In a report to Congress, GAO said that "while this adjustment appears to substantially offset the over-estimates . . . this type of adjustment gives a contractor who held a high-profit contract an unfair competitive advantage over other bidders for follow-on contracts." USAF was criticized for failing to review more carefully the cost estimates in the first contract.

BASIC BUILDING BLOCKS FROM KEARFOTT

Data Logging

Kearfott's broad line of test equipment includes the Scanalog 200-Scan Alarm Logging System which monitors, logs and performs an alarm function of up to 200 separate temperature, pressure, liquid level or flow transmitters. This precise data handling system is equipped with manual controls for scanning rates, automatic or manual logging, data input relating to operator, time, day, run number and type of run. 200 numbered lights correspond to specific points being maintained and provide a visual "off normal" display for operator's warning. System can be expanded to 1024 points capacity and 2000 points per second scanning rate.

Write for complete data.

BASIC BUILDING BLOCKS FROM KEARFOTT

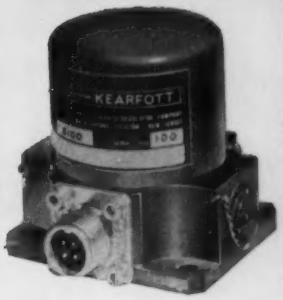
Floated Rate Integrating Gyros

Specifically designed for missile applications, these Kearfott miniature gyros operate efficiently at unlimited altitudes. Their outstanding accuracy and performance make them superior to any comparably-sized units on the market. Hermetically sealed within a thermal jacket, these gyros are ruggedly designed and completely adaptable to production methods. Performance characteristics that are even more precise can be provided within the same dimensions.

TYPICAL CHARACTERISTICS

Mass Unbalance:
Along Input Axis: 1.0°/ hr maximum untrimmed
Standard Deviation (short term):
Azimuth Position: 0.05°/hr
Vertical Position: 0.03°/hr
Drift Rate Due to Anisoelasticity
Steady Acceleration:
.015°/hr./g^2 maximum
Vibratory Acceleration:
.008°/hr./g^2 maximum
Damping:
Ratio of input angle to output angle is 0.2
Characteristic Time:
.0035 seconds or less
Weight: 0.7 lbs.
Warm-Up Time:
10 minutes from —60°F
Life: 1000 hours minimum

BASIC BUILDING BLOCKS FROM KEARFOTT



Electrohydraulic Servo Valve

Kearfott's unique approach to electrohydraulic feedback amplification design has resulted in a high-performance miniature servo valve with just two moving parts. Ideally suited to missile, aircraft and industrial applications, these anti-clogging, 2-stage, 4-way selector valves provide high frequency response and proved reliability even with highly contaminated fluids and under conditions of extreme temperature.

TYPICAL CHARACTERISTICS

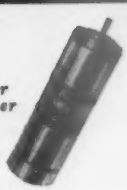
Quiescent Flow ..... 0.15 gpm
Hysteresis ...3% of rated current
Frequency Response
3 db @ 100 cps
Supply pressure....500 to 3000 psi
Temperature-Fluid & Ambient
—65°F to +275°F
Flow Rate Range .... .3 to 10 gpm
Weight ..... 10.5 ounces

Write for complete data.

Analog Digital Converter

20 Second Synchro

Integrator Tachometer



Engineers: Kearfott offers challenging opportunities in advanced component and system development.

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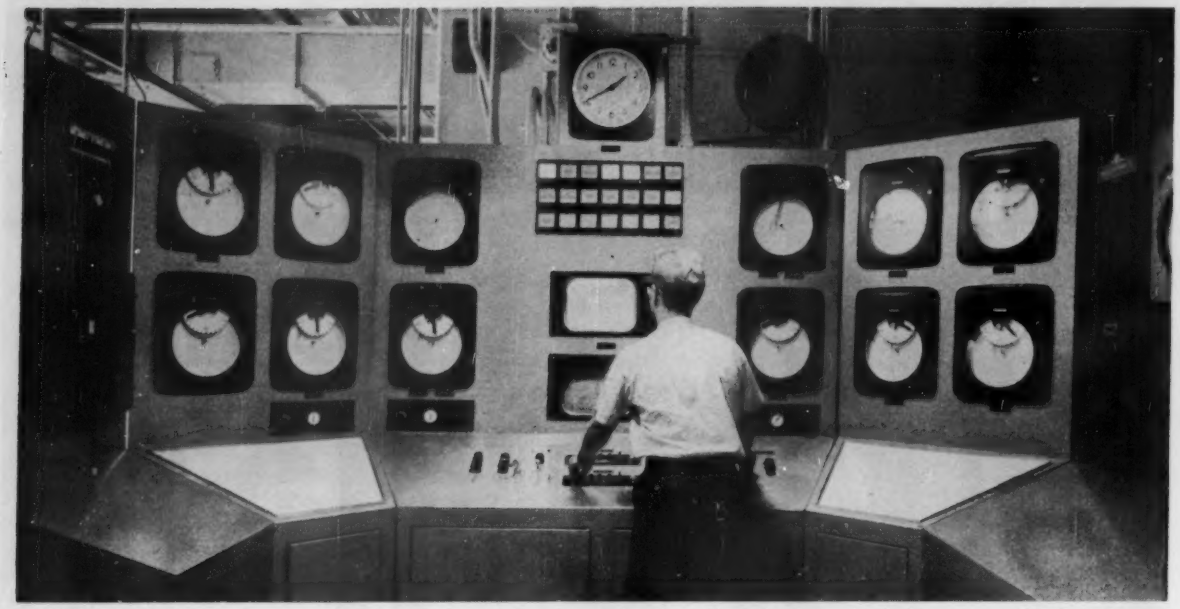


CONTINUOUS MIX control room undergoes evaluation in Longhorn pilot plant. Note closed circuit television screens directly in front of operator. Process, being studied for installation in new Longhorn integrated production facility, entails mixing ingredients in bay adjacent to casting bays, pumping them through pipelines into motor casings.

Longhorn Plant Adds Propellant Capacity

Marshall, Tex.—Significant increase in U.S. large solid-propellant rocket motor production capability for tactical and strategic missiles will be available when U.S. Army's Longhorn Ordnance Works new integrated facility near here, the largest of its kind in the country, is completed within the next 45-90 days.

Indications are that the new plant will nearly double Longhorn's present designed production capacity of approximately 500,000 lb. of solid propellants monthly.

Essential construction, plumbing and services have been completed and were turned over recently by Brig. Gen. William Whipple, Army Corps of Engineers, which supervised construction, to Lt. Gen. John H. Hinrichs, chief of Army Ordnance. The facility will be operated under contract by Thiokol Chemical Corp.'s Longhorn Division personnel.

TEST FIRING two-bay stand is capable of handling solid-propellant rocket motors of up to 1.5 million lb. thrust.

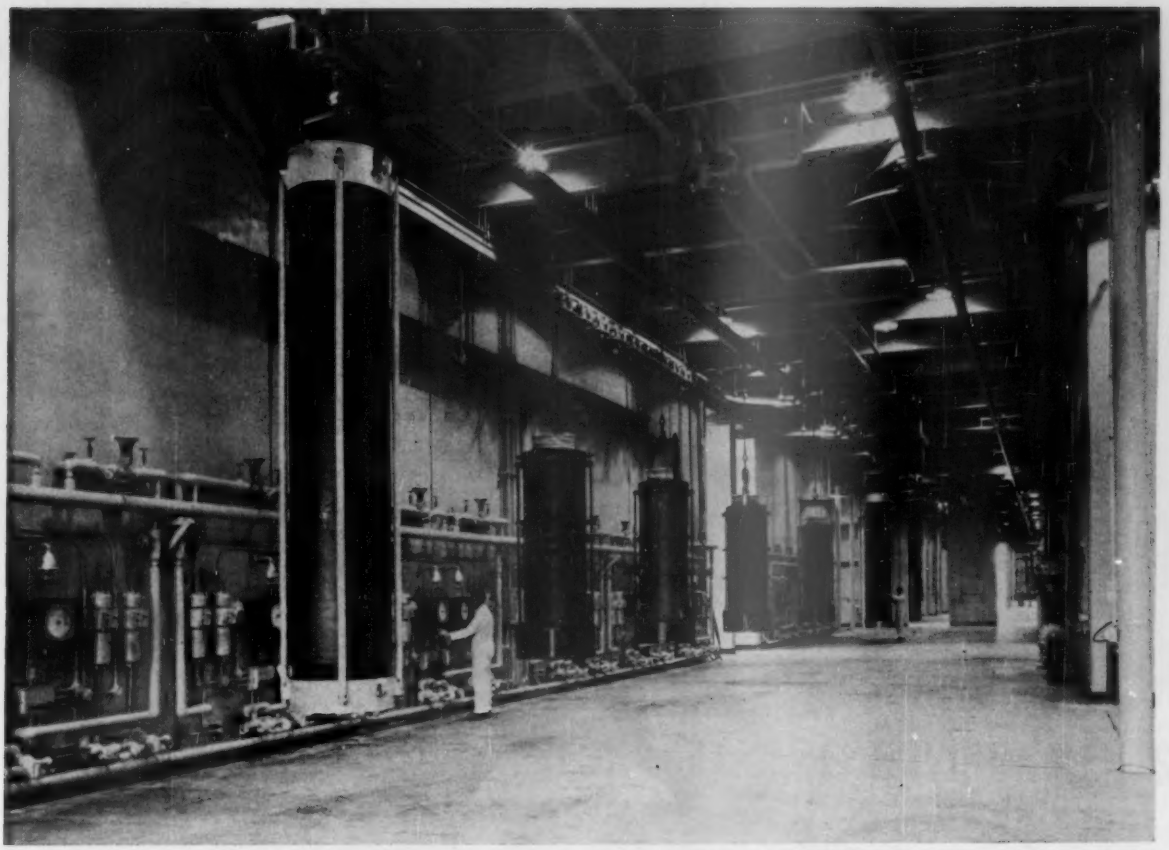
Still to be installed is production equipment, including propellant mixing gear, and some $500,000 worth of electronics. When fully completed, including yet-to-be-completed support structures, such as warehousing and change houses where personnel will change into special clothing, the new plant will have cost approximately $10 million.

Service Participation

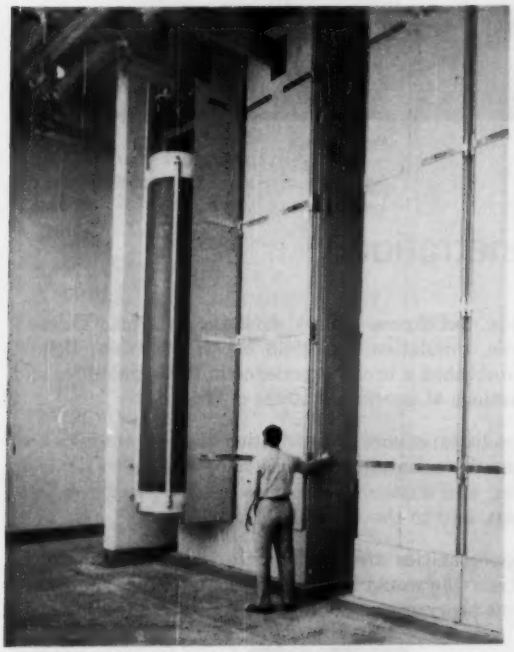
Gen. Hinrichs has, in effect, invited participation in the plant's facilities by all three services. Longhorn currently does small motor work for USAF's air-to-air Falcon (M58) missile in addition to Army work such as the XM30 sustainer for Nike Hercules, the XM10 for LaCrosse, the XM53 for Sergeant and M7 spinner rockets for Honest John missile.

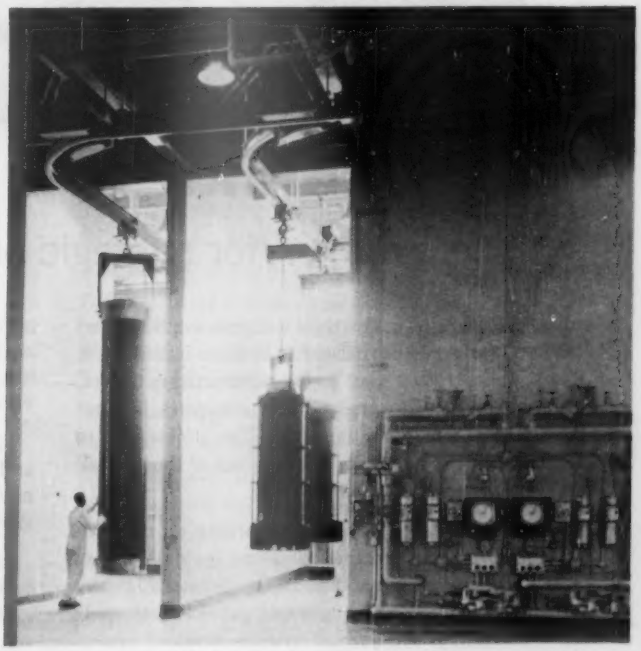
Due to current "budget exercises," according to Gen. Hinrichs, immediate work schedules for the new facility have not yet been defined, although it is expected that final assembly of XM53 Sergeant motors will be carried out here initially. Gen. Hinrichs indicated that the plant could handle production of the 450,000-lb.-thrust Nike Zeus motor here and also the USAF's Minuteman intercontinental ballistic missile motor, on which Thiokol has the initial stage production contract.

As measure of how the new plant extends Longhorn's capability, its new two-bay test cells are capable of mount-



CENTRAL operating corridor of new facility, shows portion of approximately 2,000-ft. of electrically-operated conveyor line, transporting XM53 Sergeant motors (far left and right) and XM30 Nike Hercules sustainers. A battery-powered monotractor transports each motor along overhead conveyor. Operating production bays branch off from central corridor and are all connected by conveyor.





MAHONE CURING OVEN is shown loading an XM53 Sergeant motor (picture at left). Oven doors are pneumatically operated. New facility has two banks of three such ovens. XM53 Sergeant motor (picture at right) and XM30 Nike Hercules sustainers (background) enter curing oven bays where propellant is solidified. Process is remotely controlled and monitored from central corridor.

MIXED TRICKS

... for strategic penetration

Like the Oriental juggler, strategic weapons systems need a mixed bag of tricks to be successful. Modern legerdemain for effective penetration may include camouflage, tactics, radar and infrared decoys, radar-busting missiles, bomber defense missiles, and radar jammers. The problem is to select and design the optimum combination of these possibilities for a particular weapon system.

The Bendix Systems Division is working on penetration aids for advanced manned weapons systems. It has also worked on deceptive and jamming countermeasures for unmanned weapons, and has investigated effectiveness of these techniques against defensive systems. Through analysis, simulation, and field experimentation, Bendix has established a broad experience in the capabilities and interactions of weapons systems of the future.

Bendix experience in penetration aids, countermeasures and counter-countermeasures is being applied to strategic manned and unmanned weapons systems, to air defense systems, and to the EAGLE Missile System.

Opportunities are available to better engineers and scientists who would like to participate in these and other systems programs of the highest technical integrity.

Bendix Systems Division
ANN ARBOR, MICHIGAN

Bendix
AVIATION CORPORATION

ing motors delivering up to 1.5 million lb. thrust.

Over-all design and development of specifications for the new complex were handled by Ralph M. Parsons Co., Los Angeles, Calif., which worked under two contracts. One was from Thiokol to do development and design and prepare specifications for all the equipment going into the facilities; the other was with the Army Corps of Engineers' Little Rock District to handle plans for the brick and mortar phase. Corps of Engineers, in turn, put the construction job out on a bid, which was won by Brown & Root, Inc., Houston, Tex.

Production Building

Production building itself measures some 460 ft. long and approximately 120 ft. wide. It is laid out so that propellant ingredients and other motor materials come in at one end and finished rocket motors are packed out at the other. Prior motor production facilities encompassing similar processing at Longhorn now entail use of three or four separate structures to do the same job.

In the planning stage, and now undergoing evaluation at Thiokol's pilot production plant at Longhorn, is a continuous propellant mixing process, which is being studied for installation in the new plant. In this operation, propellant is mixed in a bay adjacent to casting bays, then pumped via pipelines to motor casings in casting bays. Current method is to mix ingredients, pour them in a casting can which is then transported to casting area and then poured.

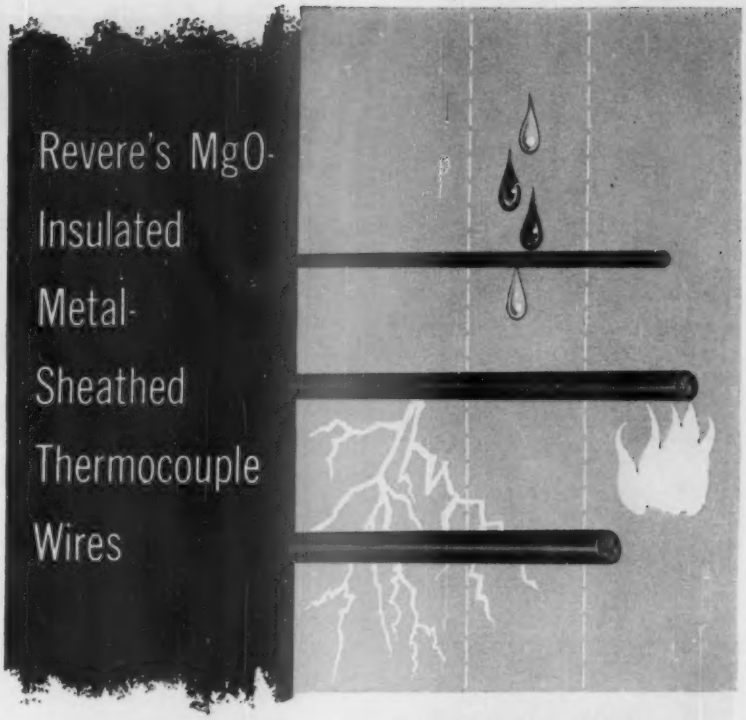
The new building contains some 2,000 ft. of overhead conveyor lines which transport the motor casings along the central corridor or into and out of the various isolated production bays that line each side of the corridor, handling casting, core insertion, curing, painting, core cleaning, storage and shipping.

Remote Control

Operation will be by remote control, Longhorn Division personnel utilizing periscope and remote television equipment for monitoring.

Two banks of three steam-heated Mahone ovens are used for curing, each oven is capable of taking one or two motors depending on size—either one XM53 Sergeant motor or two XM30 Nike Hercules sustainers.

At the facility's temperature conditioning building, where motors are heat- or cold-soaked prior to firing to simulate variety of climatic conditions encountered in field service, some 225,000 lb. of rocket motor propellants can be processed at a single time. Temperatures ranging from −80F to +180F can be simulated here.



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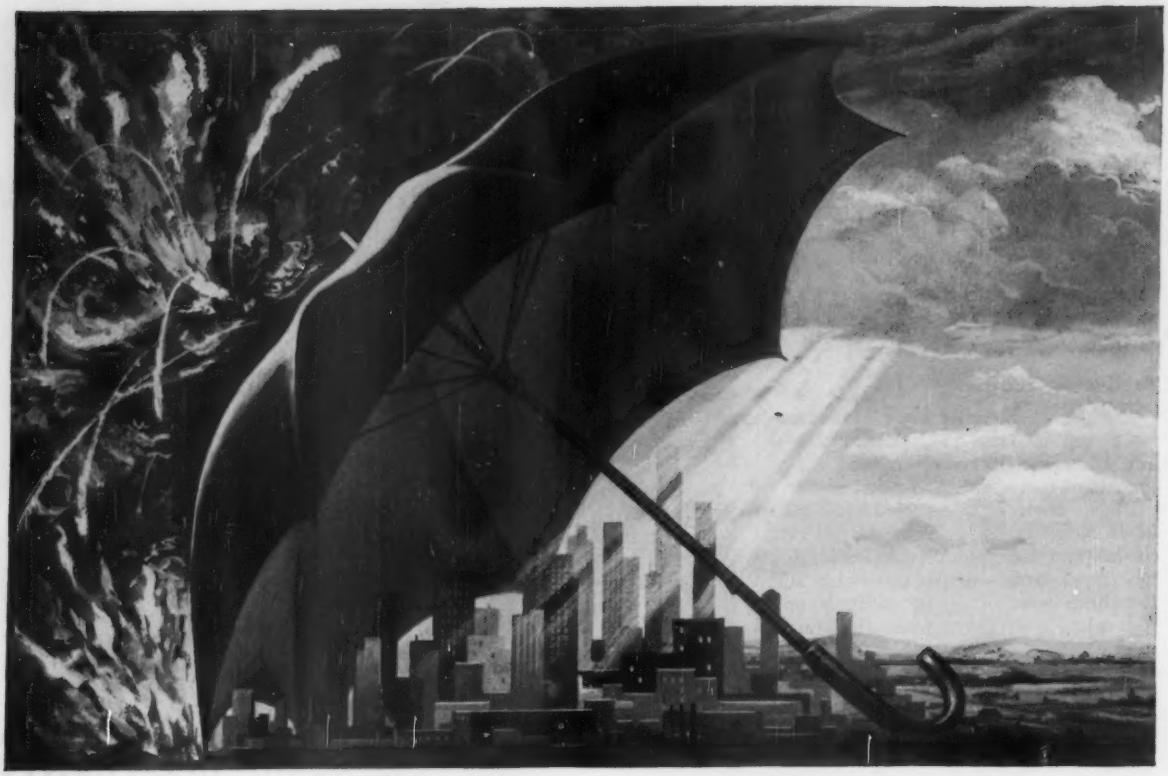

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MILITARY ELECTRONICS DIVISION CHICAGO 24, ILLINOIS

URGENT PROBLEMS RELIABLY SOLVED

SYMBOLIC of changing nature of aircraft industry is the specialized type assembly area required, such as at Autonetics.

Expanding Avionics Engineer Market—Part II:

Aircraft, Avionic Firm Differences Fade

By Philip J. Klass

Washington—"It is getting harder and harder to tell the difference between many of the nation's aircraft companies and many of the manufacturers of avionics equipment," according to a top Air Force procurement official.

For example, a company such as Raytheon bears a closer resemblance to a firm such as Martin, than it does to a predominantly non-military electronics producer like Zenith, the official points out.

System Competition

In growing numbers of military weapon and support system competitions, avionics companies are pitted against aircraft companies. For example, in the pending Army Mauler air defense missile competition, the four bidders are General Electric, Sperry Gyroscope, Martin, and a team consisting of Convair Division of General Dynamics Corp. and Raytheon.

In the recent Air Force Airborne Long Range Input (ALRI) competition to convert Lockheed RC-121Ds to feed radar target information directly into SAGE center, the bidders include two aircraft companies and six avionics firms (AW Sept. 21, p. 23).

Today, one out of every four engineers on aircraft company payrolls is an electrical-electronic engineer, and the ratio is expected to be one out of three by 1964, an AVIATION WEEK survey reveals.

At major electronics conventions during the past year, companies such as Lockheed, Martin and Republic are among the most active recruiters on the scene.

Five years ago this trend, first reported by AVIATION WEEK (Dec. 27, 1954, p. 42) was largely motivated by aircraft company needs for more avionic know-how to integrate growing numbers of increasingly complex avionic equipments on an aircraft or missile. This need is still present, still growing. However, some observers see an even more important motivation today: survival.

Growing cost and complexity of weapon systems which must be produced within the constriction of a fixed defense budget means fewer types of weapons and fewer numbers of each type. Concurrent with this contraction of the military aircraft and missile market, in terms of numbers, is the growing market for ground support, communications and complex data processing equipment.

Many, but not all, aircraft companies have taken steps which suggest that

Future Trend

The extent to which aircraft manufacturers have moved into the development and manufacture of avionics equipment, as measured by the number of electrical-electronic engineers they employ and their output of avionic equipment, was reported last week (Oct. 5, p. 97), based on data disclosed by an exclusive Aviation Week survey. The results of this trend, and its implications for the future, are described in this concluding article of the series.

ANOTHER characteristic change at many aircraft companies finds women operating soldering irons instead of rivet guns.

they intend to further expand their avionics activities:

• **Lockheed** has set up a semi-autonomous Electronics and Avionics Division to develop and manufacture hardware for military and industrial markets. Company has just completed the acquisition of Stavid Engineering, Inc., East Coast avionics company which last year had sales of more than $11 million. Lockheed has held preliminary acquisition conversations with Lear and a number of other avionics firms.

• **Northrop,** which earlier set up its avionics activities in a semi-autonomous Nortronics Division, has more recently acquired Page Communications Engineers, a consulting engineering and management firm in the communications field. Earlier, a near-merger between Northrop and American Bosch Arma Corp. fell through after long negotiations.

• **Martin,** which has built up its extensive avionic capability entirely through internal expansion, conducted exploratory merger discussions earlier this year with General Precision Equipment Corp.

• **Temco,** which has a sizable internal avionics capability, acquired Fenske, Fedrick and Miller, Inc., an avionics company that produces electro-optical display devices.

Aircraft companies generally can be divided into one of three categories in terms of their basic philosophy of avionics activity, with a few exhibiting a dual or split personality.

• **System integration:** Here the primary role of the avionics engineer is to perform systems integration of complex avionic equipment for the company's own weapon systems and to monitor development by outside avionics companies. This category includes such firms as Douglas, Grumman, McDonnell and Republic, and the aircraft divisions of Convair, Lockheed, North American and McDonnell.

• **Hardware production:** These companies have established distinct and usually autonomous divisions expressly to develop and manufacture avionics hardware in competition with outside suppliers. This category includes such companies as Bell, Lockheed, Martin-Orlando, North American, Northrop and Ryan.

• **Grey area:** Between the two foregoing groups of companies is another of comparable size which usually purchases its avionic development and hardware outside, but which has a capability for development and perhaps production in certain specialized areas. Line of demarcation between this group and the others is frequently faint. Group includes such companies as Boeing, Convair-Pomona, Chance Vought, Martin-Baltimore and Temco.

Little Change

Despite the sizable increase in the size of avionics staffs in all aircraft companies during the past five years, there has been surprisingly little change in the companies grouped in each category. Lockheed has made perhaps the most dramatic shift. Five years ago the bulk of its avionics engineers were used for systems integration work. Chance Vought and Temco have moved from this group into the grey area, and Republic shows signs of making a similar move.

Five years ago there was considerable concern expressed by officials of avionics manufacturers over the increasing interest of aircraft companies in moving into their field. This concern was magnified by the trend toward the weapon system management concept. There were real fears that an aircraft company holding a weapon system prime contract would develop and manufacture a sizable portion of the avionics equipment that went into its weapon system.

Today, despite the increased concentration of avionics engineering talent in aircraft companies, there is far less worry in avionics companies. This is due in part to safeguards established by the Defense Department and in part to economic and other natural factors which have come into play.

For example, under Air Force Procurement Instruction 53-101, major prime contractors are required to submit their proposed "make-or-buy" list prior to final contract negotiations, indicating which items they plan to manufacture in-house and which they propose to buy outside. Air Force must approve the list before it signs a contract, and it takes a dim view of approving prime contractors in-house effort unless an established and superior avionic capability already exists.

Another restraining consideration is the fact that the government will not allow a defense contractor to make a double profit. That is, if North American buys the automatic flight control system for the B-70 Mach 3 bomber from its own Autonetics Division, the airplane division is not allowed to take a profit on the system in addition to the profit which Autonetics receives. On the other hand, if the airplane division purchased the B-70 autopilot from General Electric, both GE and North American could make a profit on the transaction.

If there were no other barrier to an airplane division buying all of its avionics from a sister division, this double-profit limitation would be sufficient to at least dull its appetite.

Being an "insider" may have certain advantages, but there are many attendant disadvantages not immediately apparent to an outsider. Officials of Bell Aircraft's Avionics Division, Nortronics and Autonetics all agree that it usually is easier to sell to an outside aircraft/missile manufacturer than to a sister division.

The chief engineer at one of these divisions put it this way: "Your sister divisions know all of your headaches and internal secrets. For example, when we submit a proposal in competition with outside avionics firms to a sister division, we must indicate whether we have sufficient manpower and facilities

Memory Plane

Temperature-controlled ferrite core memory plane, with built-in heater elements and transistorized temperature control, maintains cores at temperature of 85C over ambient temperature range of −55C to 85C. First models available have 16 x 16 core array, mounted in 4 x 5 x 1 in. magnesium case for airborne use. Manufacturer: General Ceramics Corp., Applied Logics Division, Keasbey, N. J.

to handle the project. While our competitors' statements are accepted as gospel, our statement of adequacy is challenged because at a recent top corporate management meeting we had asked for additional manpower and new facilities.

"If we decide to submit a proposal to a sister division," this chief engineer continues, "we know it has to be head and shoulders above the closest competition, otherwise we don't stand a ghost of a chance. And if we decide that the deck is stacked against us and submit a bid to other aircraft/missile companies competing for the prime contract, they ask us why they should buy our stuff if it's not good enough for our own 'kinfolk.'"

Military Security

An airframe/missile division knows that when it recommends the use of avionics equipment produced by a sister division that this choice must run the gauntlet of military scrutiny and will be viewed with a suspicious eye. For example, before Air Force approved the selection of Autonetics to supply the flight control systems for the B-70 and F-108, since canceled (AW Sept. 28, p. 27), it had to be removed by USAF's assistant secretary for materiel. If an outside source had been selected, it could have been approved with far less trouble.

John R. Moore, vice president and general manager of Autonetics says that "unless we're convinced that what we can offer is far above outside competition, we don't even try to compete for business from North American's airplane and missile divisions."

The North American missile division selected a Kearfott inertial guidance system for its air-launched ballistic missile (ALBM) proposal over an Autonetics

FACTS the aviation industry should have on commercial uranium

Uranium has many interesting properties.

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system. Autonetics also lost the attitude reference for the B-70 in competition with an outside firm.

On the other hand, Autonetics did pick up the guidance for the Hound Dog air-to-surface missile, the stable platform for the B-70 bombing-navigation system being developed by International Business Machines Corp., and the inertial navigator for the Navy A3J, built by North American-Columbus, plus some automatic checkout equipment for the same airplane.

Five years ago there were unanswered questions and uncertainties in the established avionics industry about dealing with a company that was both a potential customer and competitor. For example, would proprietary information disclosed in a proposal to an aircraft/missile division find its way, directly or indirectly, into the company's avionics division?

In the intervening period, avionics companies generally have come to accept this split customer-competitor personality of such companies as North American, Northrop and Martin. These firms have leaned over backward to assure isolation between aircraft/missile and avionics division. Autonetics has carried this to the point where it even has a separate Washington office from its sister divisions.

Outside Bidders

There is an understandable preference, when all other things are equal, for an avionics company to prefer to work with a company like Douglas or McDonnell which does not have a do-it-yourself philosophy. But there was no lack of outside bidders, for example, on the flight control systems for the North American B-70 and F-108, despite the fact that it was known that Autonetics would be a contender. (When Autonetics was selected, there were a few protests, but these quickly subsided.)

Five years ago, there were also questions raised as to whether the avionics division of an aircraft company could successfully sell to an aircraft/missile competitor. Some observers believed that few aircraft/missile companies would be willing to discuss their proposed bids with the avionics division of a potential competitor.

These apprehensions have been largely assuaged. In recent USAF air-launched ballistic missile competition, a Nortronics inertial guidance system was included in prime contract proposals submitted by Bell, Boeing, Convair-Ft. Worth and Hughes, even though Northrop itself was competing for the prime contract. Nortronics also is reported to be a top contender for the ALBM guidance now that Douglas has been selected as the missile prime contractor.

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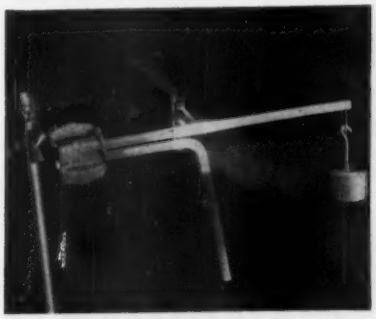
major sales to North American's aircraft/missile competitors. For example, Autonetics monopulse radar was sold to Republic for use on late model F-105's, and was recommended by Lockheed for use on the Canadian and German versions of the F-104. Autonetics is on the Boeing Dyna-Soar team, as a source of flight control and guidance, and its automatic checkout equipment will be used with the Grumman A2F, based on a Navy recommendation.

Ryan's doppler auto-navigators, purchased by the Navy and Army, are used on variety of helicopters and lightplanes built by other aircraft companies.

The avionics divisions of aircraft companies are increasingly going outside the parent company for top sales personnel, hiring men from established avionics companies who are used to dealing with airframe/missile manufacturers as customers instead of as competitors.

Translucent Ceramics

Lucalox, new translucent ceramic material developed by General Electric, has the high strength of alumina ceramics, but passes light and can withstand much higher temperatures. New ceramic can be pressed into any desired shape, GE says.



Extremely high temperature characteristic of Lucalox is demonstrated above. At temperature of 2,350F, bar of ordinary quartz bends under its own weight, while Lucalox supports a 50 gram weight at same temperature, even up to 3,200F, GE reports.

The newly formed Lockheed Electronics & Avionics Division is one of several dozen companies, possibly including Autonetics, that has submitted bids to North American for B-70 ground checkout equipment. Nortronics also is believed to have made a bid.

The one safe prediction about the future of avionics in the aircraft industry is that it will continue to grow in importance. AVIATION WEEK's survey indicates that by 1964, aircraft manufacturers expect to employ nearly 29,000 electrical-electronic engineers, roughly twice as many as it employs today and four times as many as it employed five years ago.

Today, aircraft manufacturers produce an estimated $900 million annually in avionics hardware. By 1964, they expect to manufacture nearly $2 billion a year, AVIATION WEEK's survey reveals. Approximately two-thirds of this output goes into their own weapon and support systems, one-third is sold to outside firms.

Whether additional aircraft companies will follow in the pattern of Bell, Lockheed, North American, Northrop and Ryan in setting up separate and distinct avionics divisions remains to be seen.

Some observers believe that with the present tight supply of engineers and scientists, it will be difficult to build up such divisions by internal expansion. Some believe that Lockheed may have such difficulties in building up its new division. Similar doubts were expressed several years ago when Lockheed decided to enter the missile field as a relatively late starter. Its present position in the missile and space fields indicates what can be done despite a late start if a company goes all-out. Still, some observers doubt whether lightning will strike twice.

Another approach is by acquisition of small avionics companies, a route which both Lockheed and Northrop have explored on a limited basis. This is a speedy way to acquire a group of avionic engineers, know-how and product lines. However, an incautious acquisition spree can lead to severe industrial indigestion and integration problems as many non-aviation companies which jumped into the electronics field by acquisition have found out.

Even with the recent declines in the stock market, most promising electronic company stocks are selling at a price-to-earnings ratio which is several times that of aircraft manufacturers. This means that an aircraft company must pay a rather steep price for worthwhile acquisitions, diluting its own price-to-

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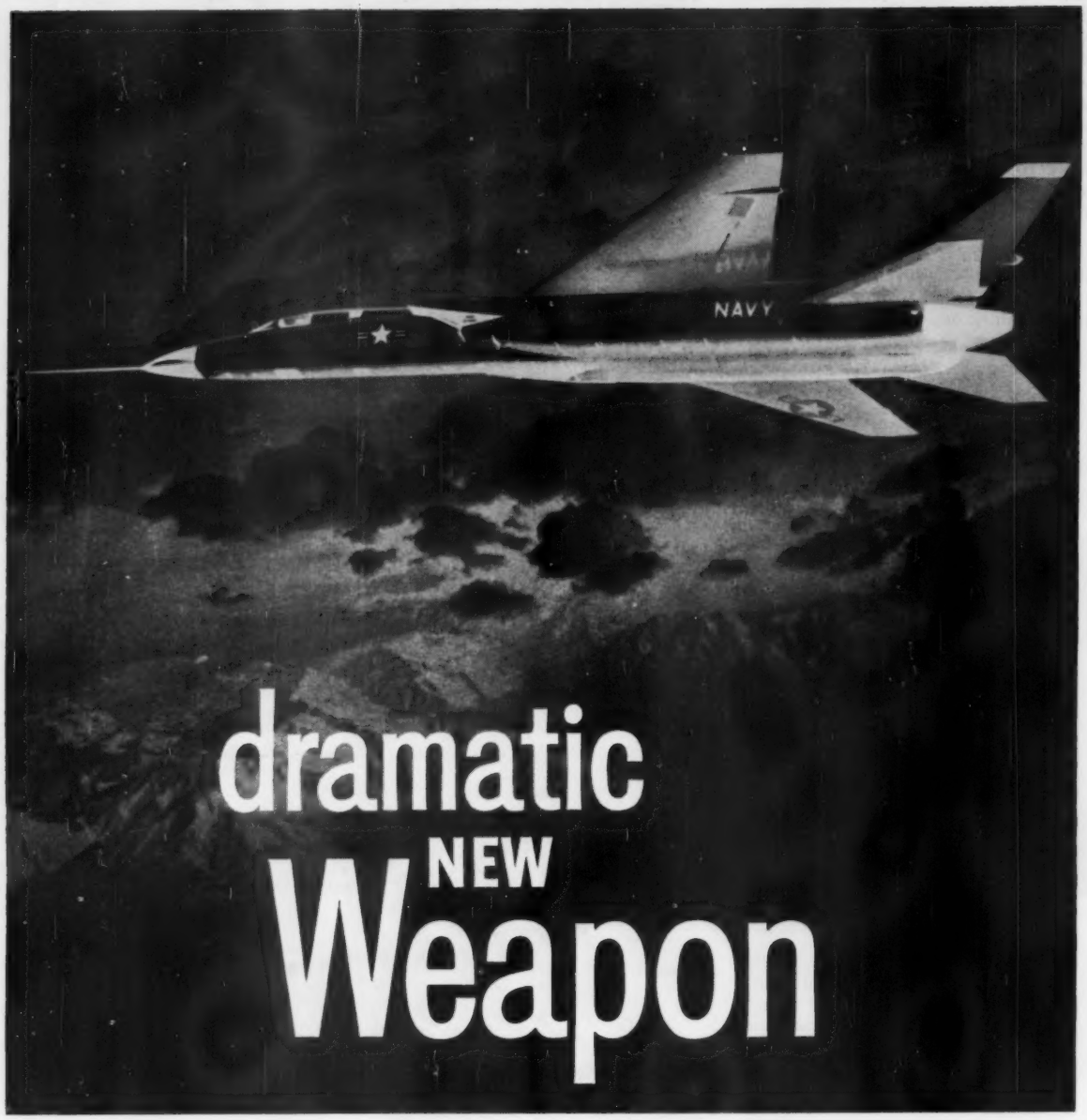

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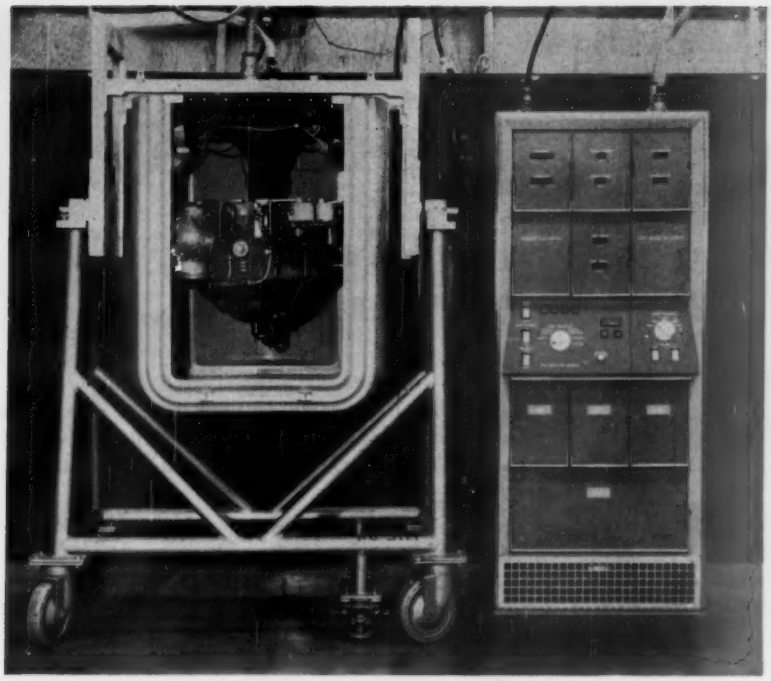

Inertial Guidance for Polaris Sub

Polaris submarine inertial guidance system, the N7A, produced by North American's Autonetics Division, is shown in first photograph. Gyro-stabilized platform is shown at left. At right is digital computer which performs inertial computations to establish submarine position prior to launch. Sperry Gyro produces inertial system for Polaris submarines.

earnings ratio for the immediate future. This was the major stumbling block to the proposed merger between Northrop and American Bosch Arma Corp. Northrop wanted a stock exchange ratio based on current earnings, while Arma wanted to base it on the current market price of the two companys' stocks.

There are other reasons why separate avionics divisions may not become a near-universal pattern for the industry. In a recent talk to the New York Society of Security Analysts, General Dynamics board chairman Frank Pace, Jr., said that when his company acquired Stromberg-Carlson, "we believed that it would be our center of electronic activity, but we found that electronics was so important, so varied in its scope and growing so rapidly, that this function could not be encompassed within one division.

"We found it essential to greatly expand this activity at Convair, where it was already important," Pace said. "Today, Convair approaches Stromberg-Carlson in terms of total volume of electronics business and its activities in this area are increasing rapidly," Pace added. (General Dynamics does not release sales figures for individual divisions, but Stromberg-Carlson sales are believed to be in the neighborhood of $100 million annually.)

Martin is another company where much of the avionic capability is integrated within divisions whose primary goal is to produce weapon systems, not merely avionics systems. In Martin's Orlando Division, which is developing the Bullpup and White Lance air-to-surface missiles, the Pershing surface-to-surface missile, and building the La-Crosse tactical surface-to-surface missile, three out of four engineering managers and its chief engineer are all electronic engineers.

Proponents of this integrated operating philosophy point out that electronics usually is a means to an end—a useful weapon or support system—and not an end in itself. Furthermore, they believe that aircraft companies, even with separate avionics divisions, can never hope to compete with small avionics companies in the field of relatively simple devices and subsystems.

An aircraft company, because of its size and built-in checks-and-balances, can never hope to compete with a small avionics company in terms of speed or flexibility on relatively simple devices or subsystems, many observers believe. The same applies even to separate aircraft company avionics divisions, they say.

The area in which aircraft companies can successfully compete is in the more complex and sophisticated weapon and support systems, where they are bidding

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What's in a warhead?

Warhead system performance is always critical. In order that the device be safe, armed and detonate upon delivery, the safing, arming and fuzing functions must perform as one system in perfectly timed sequence.

The *safing* system maintains the warhead in a safe condition during handling, launching and flight until the missile has reached a safe distance away from the launch site and friendly troops. Designed to prevent arming and fuzing operations until the projectile nears the target area, this system must be flexible. Maximum safety can be provided through utilization of components which sense such things as minimum preset altitudes or missile velocity. Honeywell makes accelo switches, baro switches and timers for safing systems.

The *arming* system will examine the flight path of the missile, define range, cross range and preset altitude dimensions. The arming system will then decide, based on data collected, whether to prepare the missile for self destruction or on-target detonation! Honeywell makes inertial instruments, timers, baro switches and temperature switches for use in arming systems.

The *fuzing* system, using ultra-sensitive pressure, proximity, time or acceleration sensors, assures precise detonation when and where desired. The method of fuzing may be air burst, contact burst or air burst with contact burst as a backup. If the mission is to be aborted due to a malfunction of any missile subsystem or component, the warhead may be dudded almost to the time the fuzing process begins. Another possible action is called destruct, which means the warhead will be harmlessly destroyed high in the air. Honeywell makes infrared, baro switch, timer, radar, electrical or piezo electric, mechanical and hydrostatic fuzes for warhead fuzing systems.

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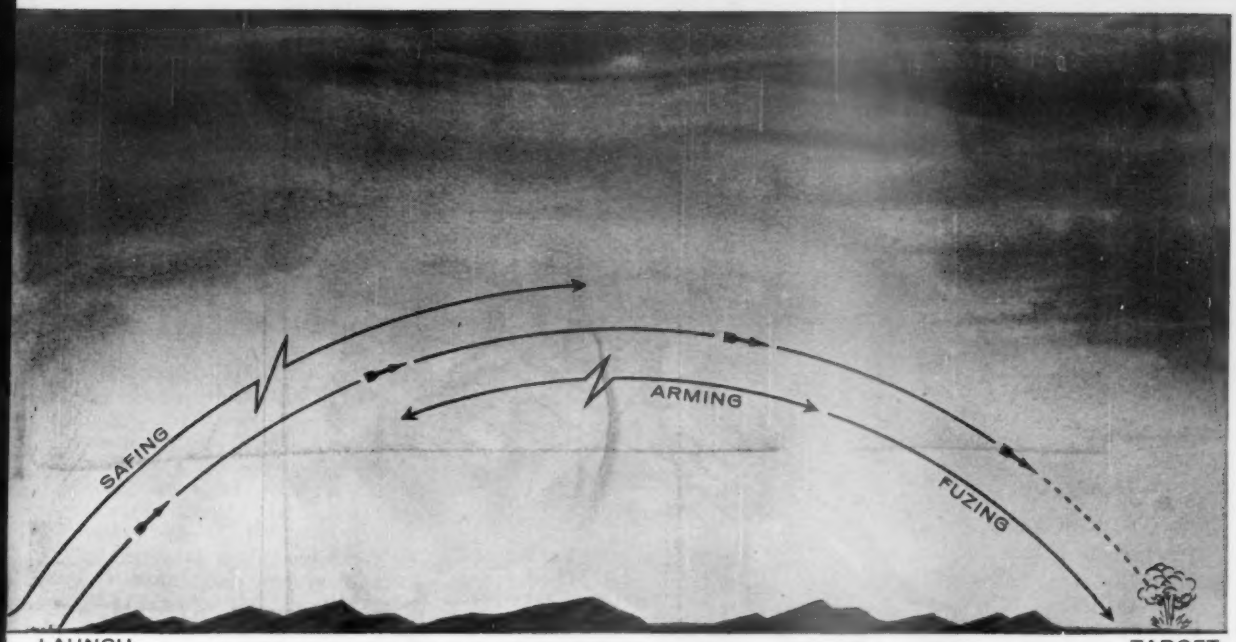

There are 3 basic systems in a warhead section. *Safing* for storage, launching and flight over friendly territory, *arming* to make warhead capable of exploding, and *fuzing* to assure precise detonation.

GLOSSARY OF WARHEAD TERMINOLOGY

1. Adaption Kit—Those items peculiar to the warhead installation less the warhead; namely, the arming and fuzing systems, power supply and all hardware, adaptors, skins, etc., required by a particular installation.

2. Arming System—That portion of the weapon which derives (originates) the signals required to arm, safe or re-safe the firing system. Will normally consist of accelerometers, arming baros or similar components.

3. Dud Probability—(Warhead Section)—The probability that the warhead fails when launched at a target to produce a nuclear detonation at the desired location.

4. Firing System—That portion of the weapon which, upon signal from the arming system, transforms and stores electrical energy, and upon signal from the fuzing system, discharges this stored electrical energy to detonate the warhead.

5. Fuzing Systems—That portion of the weapon which derives (originates) the signals which discharge the firing system. This system normally consists of such components as pressure, proximity, time or acceleration sensing.

6. Minimum Burst Height—That height above which only an acceptable degree of ground contamination will occur.

7. Premature Probability—The probability that a weapon/warhead explodes before reaching the intended point of detonation in space, including allowable space tolerances.

8. Safe Burst Height—That height above which only an acceptable degree of damage will occur to friendly ground installations.

9. Safing System—That portion of a weapon that integrally contains all the apparatus which, on receipt of proper signals from the arming system or by manual operations, functions so as to place the warhead system in an armed or safe condition.

10. Atomic Warhead Section—That portion of an atomic weapon which consists of the warhead and the adaption kit.

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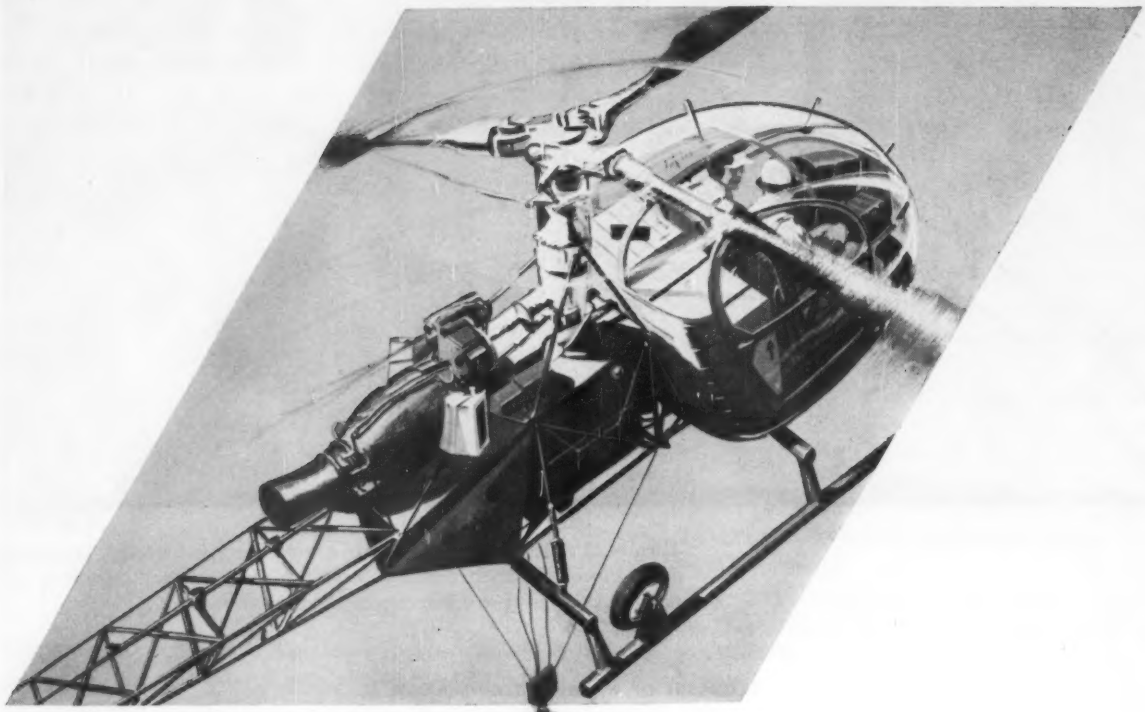

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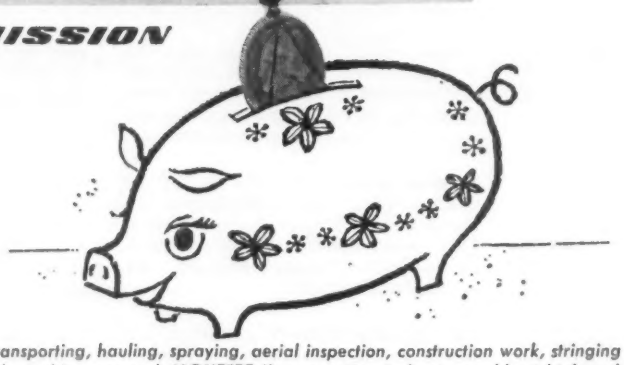

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against equally large and relatively slow-moving avionics companies, these observers believe.

This view is supported by the evidence to date. With only a few exceptions, aircraft companies have made their most successful inroads into avionics manufacturing in the field of moderately complex systems and subsystems. The exceptions are largely specialized devices like tape recorders, telemetry, missile-borne television cameras, developed by aircraft companies originally for use on their own weapons. Even Ryan's doppler radar auto-navigator is an outgrowth of original company development for missile guidance.

Except through outside acquisitions, it appears doubtful that aircraft companies will become a dominant factor in the small avionic devices, components and subsystems fields. However, in an industry which is undergoing a major transition due to technological progress, no long-range prediction can be made with certainty.

The aircraft industry generally has two characteristics which are vitally important to success in the avionics field: An awareness of the importance of technological progress, and the willingness to plunge heavily on a business which is filled with gambles.

Semiconductor Unit Offers Varied Uses

Pasadena, Calif.—Novel semiconductor device which can be used as a potentiometer, rotary resolver, non-linear function generator, analog multiplier or a light-direction scanner has been developed here by Giannini Controls Corp. The basic technique makes use of the photo-conductive properties of semi-conductor materials.

Potentiometers and rotary resolvers which employ the new technique are called Photo-pots. They provide infinite resolution, require no brushes, contacts or other mechanical moving parts. This makes the device attractive for use as a pick-off on gyros or other equipments where there must be no load or torque-feedback from the pick-off.

The Photo-pot can be operated from d.c. or a.c. current and can be fabricated with a variety of output resistances, ranging from one ohm to many megohms, Giannini says.

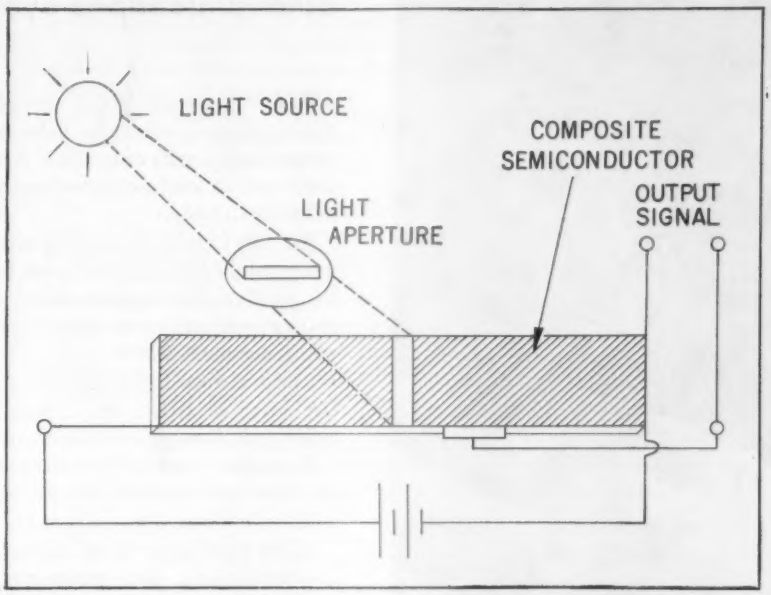


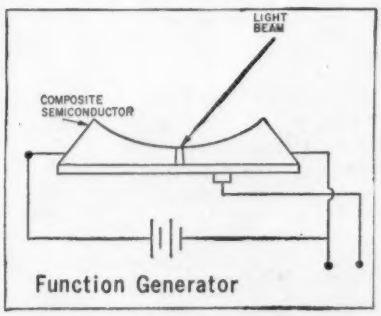
PHOTO-POT semiconductor device can be use as potentiometer or rotary resolver. There are no moving mechanical brushes or contacts. Output signal is direct function of position of light beam along strip of composite semiconductor material, giving infinite resolution.

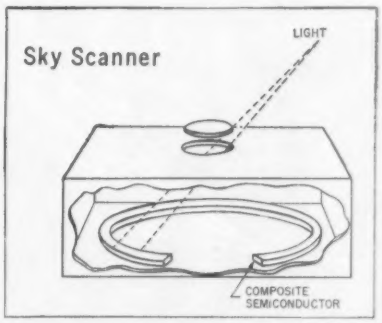
Operating Principle

The principle of operation of the Photo-pot is as follows: when used as a pick-off, an a.c. or d.c. voltage is applied across the two extremities of the strip of semi-conductor material. The output signal is obtained from a lead connected to one extremity of the strip and from a lead connected to a central terminal, corresponding electrically to the moving brush of a conventional potentiometer.

When the semiconductor strip is exposed to a beam of light, the output voltage is proportional to the relative position of the light along the strip. For example, if the light beam strikes the strip at one extremity, essentially the full excitation voltage will appear across the output terminals. If the beam strikes the opposite extremity, the output voltage will be zero. At various positions of the light beam between these two extremes, output voltage will be proportional to beam position.

The Photo-pot operates equally well with narrow or broad beams of light, with the output being a function only of its relative position and being independent of the beam width. The width of the beam affects only the effective "travel" or variation that can be achieved with a given length of photo-conductor strip.





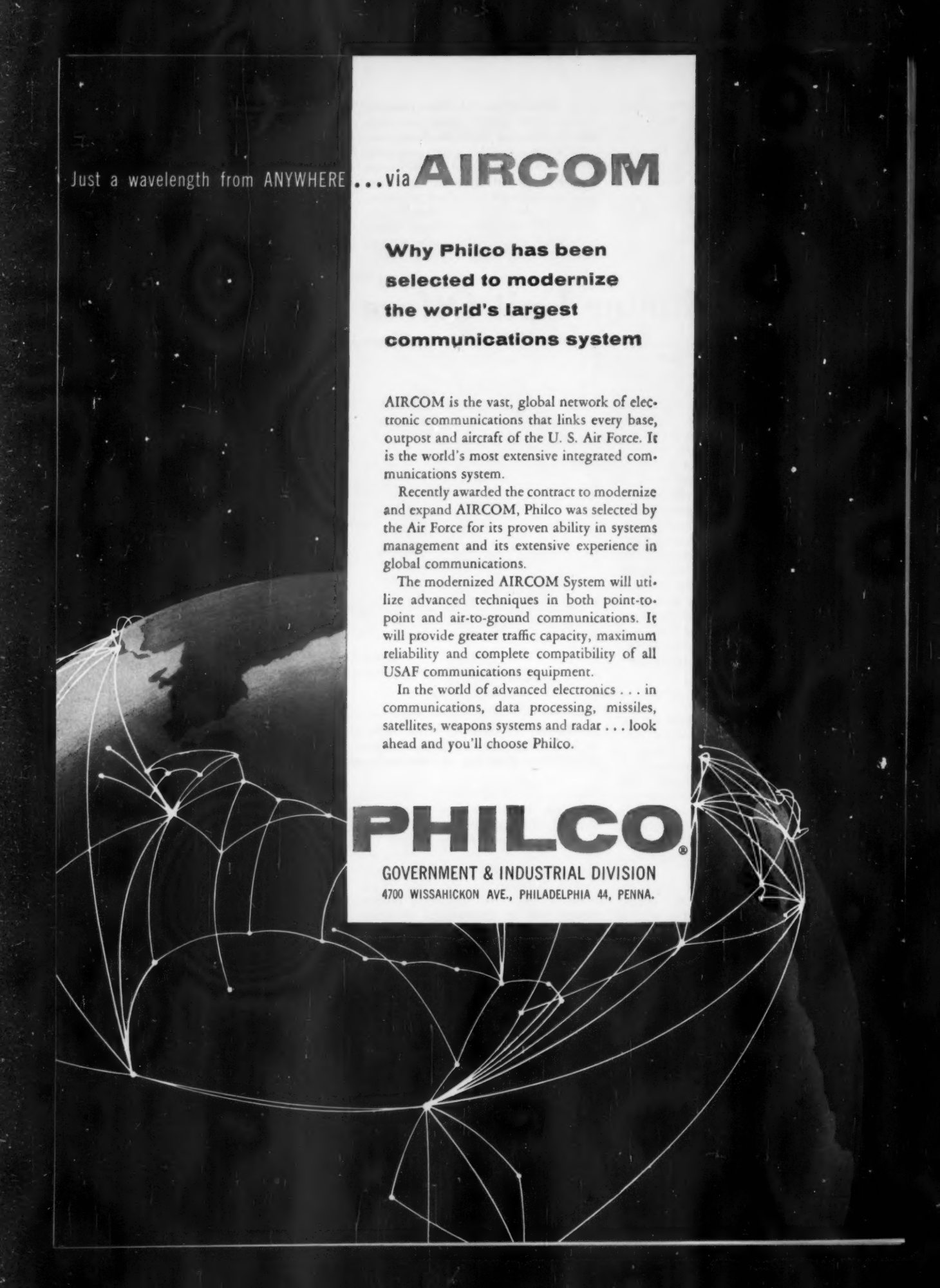
OTHER applications for new technique, developed by Giannini Controls Corp., include non-linear function generator (left), analog multiplier, and a sky scanner (right).

Output Resistances

The need to obtain a wide range of output resistances, including higher megohm values, precludes the use of a conventional semiconductor material. Giannini is close-lipped about the material used, refers to it as a "composite semiconductor material."

Present materials have a time constant of about 0.1 sec., which is fast enough for many applications. However, the company is working with new materials and is hopeful of being able to slash response time to even lower values.

Another version of the Photo-pot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under investigation by Giannini will substitute a tiny "atomic pill" of radioactive material for the light beam as a means of varying the output resistance of the device.

Giannini envisons a number of other applications for the new technique. For example, by forming the semiconductor material in non-uniform thickness along its length, it is possible to produce a function generator with almost any desired non-linear output.

An analog multiplier, with either linear or non-linear relationship, can be obtained by varying the excitation voltage across the photoconductor strip extremities as a function of one variable, while position of the light beam is shifted as a function of the other variable.

Another possibility is to operate the semiconductor at a light intensity level below its saturation, then use combination of light beam intensity modulation and position to obtain an analog multiplier. Giannini suggests that the new technique could be employed as an azimuth light-direction scanner, or star tracker, using a circular strip of the composite semiconductor and a suitable pin-hole or optical system.

At present, Giannini has no plans to market the Photo-pot as an off-the-shelf item. Rather, the company hopes to work with avionic equipment manufacturers who can use the new technique, tailoring Photo-pots to their particular needs and applications. Company's address is 918 East Green St., Pasadena, Calif.

FILTER CENTER

► **Powerful high frequency transistor**—Silicon transistor, capable of operating at frequencies of 30 mc. and power levels of 5 w., has been developed by Pacific Semiconductors, Inc., Culver City, Calif. New transistor opens the way to miniature fully transistorized radio transmitters for use in air rescue operations, the company says.

► **Advanced Power System**—Electric power system for advanced aircraft, which generates variable frequency a.c. power that is converted to constant frequency 400 cps. power by means of static devices, will be developed by General Electric under Navy Bureau of Aeronautics sponsorship. Development will be carried out at General Electric's Laboratories in Waynesboro, Va., and Erie, Pa.

► **Think Small**—Nominations for the 1959 Miniaturization Awards Competition, sponsored by Miniature Precision Bearings, Inc., Keene, N. H., are now being accepted. Award is presented an-

THE GRAND CENTRAL REPORT

In the short history of United States rocketry, solid propellant powered upper stage vehicles have established the U.S. altitude record, injected our first satellites into orbit, and have pioneered our first penetration into translunar space.

Why are solid propellants being used for these important space applications? The answer to this question is the ever increasing importance of reliability, time, and money to the competent and dedicated men who are managing our space programs.

A solid propellant rocket is inherently reliable because it is intrinsically simple. *For example, the GCR solid escape rocket for Project MERCURY will have a reliability factor of better than .99 at a confidence level of 95%.* Such a high reliability factor will really "pay off" for the giant sized multi-stage and clustered motor vehicles now being considered because the overall propulsion reliability is the product of the individual motor reliabilities.

Also, because of their basic simplicity, solid rockets can be developed in a very short time. For example, the third stage motors for the successful VANGUARD satellite vehicles were developed by Grand Central Rocket Co. in the brief space of nine months.

Finally, because of their simplicity, reliability, and short development time, solid rockets have proved to be the least expensive form of rocket propulsion.

Here, then, in the field of low-cost instrumented space probes, is an area where solid propellant rockets are in the ascendancy. I believe the next few years should see the development of very large solid propellant rockets. These may be used for launching tremendous payloads into orbit, and from there, man will eventually penetrate into the far reaches of interplanetary space. We will use low thrust nuclear powered rockets for interplanetary transfer, but I believe we will take reliable high thrust solid rockets with us for the descent maneuvers to the new worlds, and for safe return to our Earth.

These events will trace Man's first struggling steps into deep space and forever welcome him to his ultimate environment, the Universe.

H. L. Thackwell, Jr.,
Vice-President Advanced Concepts

(If you have the qualifications that a fast-moving space propulsion team needs, contact our Director, Personnel. Openings now for chemists and engineers.)

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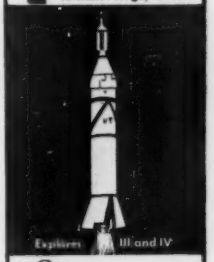
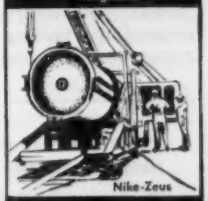

Explorers III and IV

Far Side

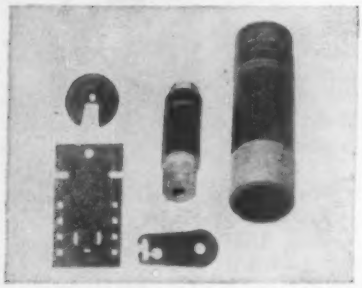
Vanguard


Nike-Zeus

Test Sled

PROGRESS IN PLASTICS

HIGH-TEMPERATURE STRUCTURAL PARTS FOR MISSILES FROM NEW DILECTO® LAMINATES



Fabricated parts made from new CDF Dilecto® high-temperature-resistant laminate, grade AAA-HR.

A new CDF laminate, Dilecto AAA-HR, can be used in short-time ablative applications in rockets at temperatures of 5,000°F, and in continuous industrial service at temperatures approaching 500°F.

The new CDF Dilecto laminate demonstrates an ablation rate of from 0.0052" to 0.0072" per second by gases at 4,700°F and Mach 2.5. This rating makes Dilecto AAA-HR suitable for parts in direct contact with burning rocket propellants.

Negligible change in dimensions and mechanical properties has been noted in finished parts subjected to temperatures of 300 to 350°F in dry or wet heat. Other tests show that these laminates retain their mechanical properties after 2-hour immersion in boiling water or 30-day immersion at room temperature.

Made from extra-long-staple nonferrous crude asbestos fiber, impregnated with a high-temperature-resistant phenolic resin, these new Dilecto laminates are recommended for applications requiring continuous exposure to temperatures up to 500°F, intermittent service up to 900°F, and for short-time exposure to 5,000° F. The laminates may be machined by conventional techniques. Parts molded from CDF Celoron® 22HR and Celoron 26HR are used where a molding rather than a machined part is desired. Celoron 26HR is used in missiles, and Celoron 22HR is intended for industrial use.

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Designed for safe transport of radio receivers, transmitters, radar equipment, and other delicate aircraft instruments between field stations and overhaul points, new CDF lightweight containers are manufactured to ATA Packaging Committee specifications.

They're made from 100% CDF Diamond® Vulcanized Fibre, riveted and reinforced with steel corners and other hardware. The inside is completely padded with a 1½ to 2" thickness of canvas-covered polyurethane foam, for maximum protection of the instrument within. Flush-fitting metal handles facilitate plane-loading and prevent damage to other luggage.

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nually in recognition of outstanding contributions to the advancement of the field of miniaturization, with additional certificates of excellence to the next 10 best entries. The 1958 award went to the Martin Co. for development of SNAP III radioisotope power generator. For entry blank, write: Miniaturization Awards Committee, Box 604, Precision Park, Keene, N. H.

▶**Dielectric Problems in Space**—Research program to study which dielectric materials are best suited to use in space and what problems will arise with dielectrics in the new environment is being sponsored at Johns Hopkins University by Army Signal Corps.

▶**Ceramic for Infrared Optics**—New lightweight porcelain, which can be coated with aluminum for use as an infrared scanner collector, has been developed by Thompson Ramo Wooldridge. New ceramic material is lighter, has less thermal expansion than glass, yet has non-porous surface which can be finished to optical quality, company reports.

▶**Communications Satellite Station**—West Germany is constructing its first passive communications satellite receiving station in order to participate when NASA launches its space balloon. German station is expected to be ready by the end of the year.

▶**Signed on the Dotted Line**—Major contract awards recently announced by avionics manufacturers or the Defense Department include the following:

• **Burroughs Corp.**, Detroit, will produce a new classified communications equipment for Army Signal Corps under a $1.7 million contract.

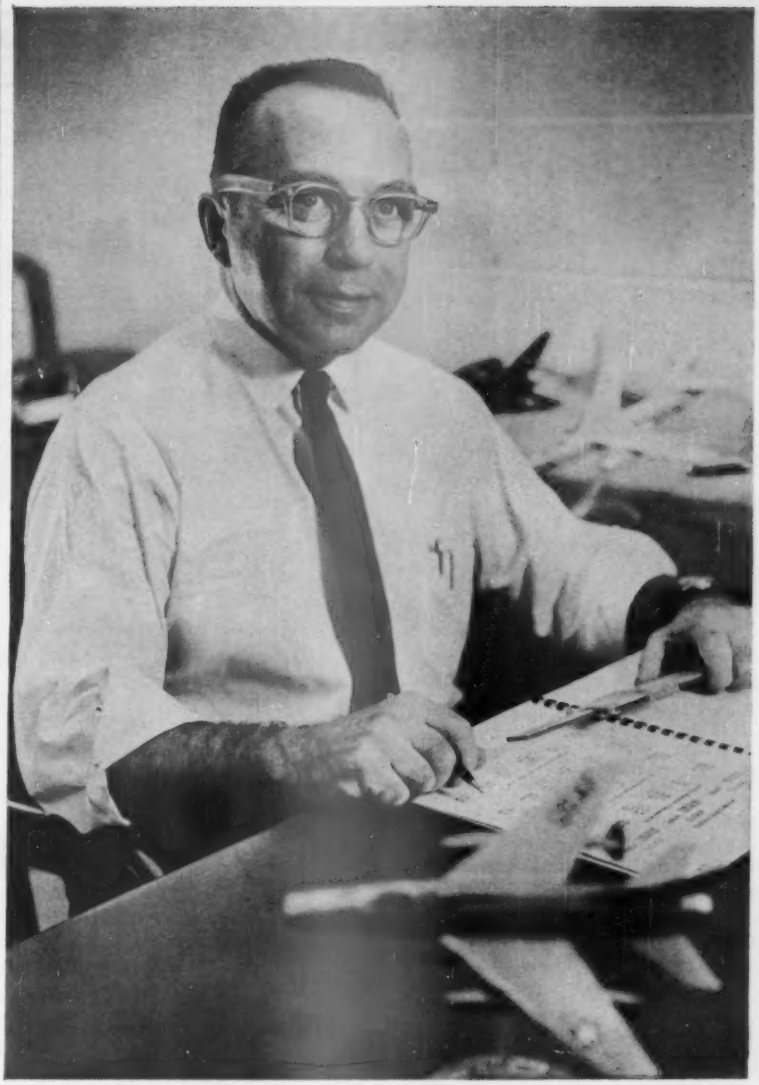
• **Sperry Rand Corp.**, Great Neck, N. Y., has received a $1.3 million award for amplifiers for the Nike Zeus ICBM defense missile development program.

• **Vitro Laboratories**, Silver Spring, Md., will develop a combination mobile deepwater television system and retrieving device for spent torpedoes under $140,000 contract awarded by Navy.

• **Litton Industries**, Beverly Hills, Calif., has received a $1.2 million contract to improve Army's Missile Master systems.

• **Minneapolis-Honeywell** will produce miniaturized inertial guidance systems for use on Army AN/USD-4 (Swallow) surveillance drones being built by Republic Aviation under $2.6 million contract.

• **Raytheon** will develop and produce new sonar detection systems for submarines, providing search, advanced communications and control of underwater fire power, under contracts totalling $30 million awarded by Navy. System will be integral part of submarine hull instead of fitted into existing hulls.



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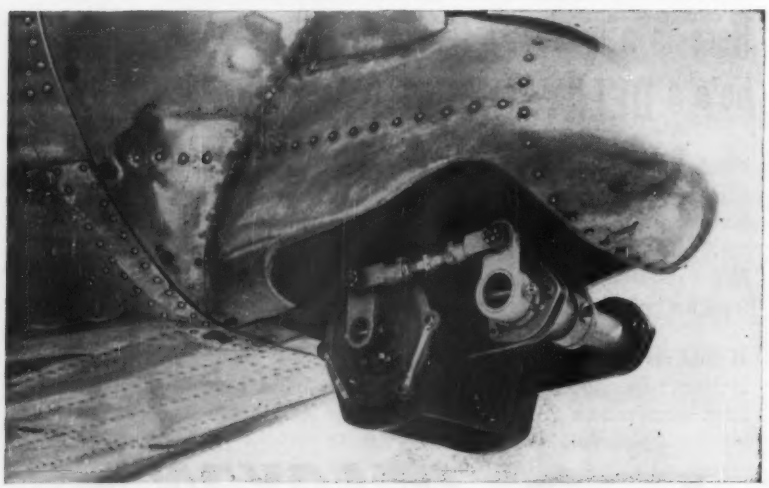
TOM BROOKE-SMITH (top of ladder), talks with company technicians before check flight. Note gills for low-speed air intakes just ahead of dorsal inlet screen. Rectangular bay under fuselage is where four lifting Rolls-Royce RB.108 engines are mounted. A single RB.108 turbojet for forward thrust is fed from dorsal inlet and conventional ducting. Note relative sizes of large fin area and small rudder area, presumably due to use of reaction control system through flight regimes critical in yaw.

Grass Hampers First Public SC.1 Flight

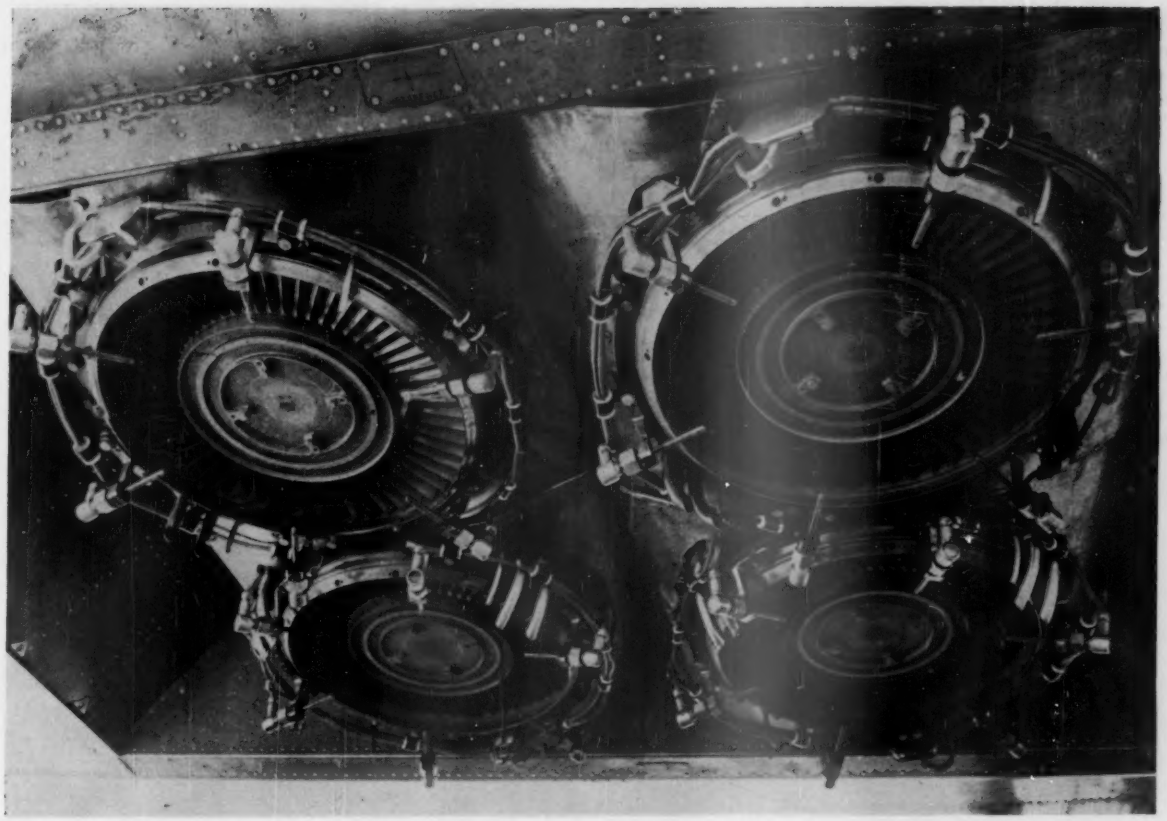


"GARGOYLE'S HEAD" houses reaction control system at nose. Jet is directed downward from box (left) throttled by a rotary valve operated by servo system to crank at right. SC.1 has automatic stabilization system developed by Short's Precision Engineering Division in collaboration with RAE.

Farnborough—Short SC.1 VTOL research aircraft, its dorsal air intake grill clogged with a thick layer of cut grass, settled back to the ground here after abrupt termination of its first public demonstration.

Pilot Tom Brooke-Smith had lifted the delta-winged plane off the sod adjacent to the main runway in a cloud of earth, dust and cut blades from the newly-mown grass. In a few seconds enough loose grass had been sucked into the grill to jam it completely—although not too suddenly—and Brooke-Smith had to ease the plane onto the runway and cut the Rolls-Royce powerplant.

"Looks like a thatched cottage," said one British engineer, and it was an apt simile. The grass blades covered the top of the SC.1 fuselage like a green roof from the rear engine inlet to the grille just aft of the cockpit. Company said it was a hazard it hadn't thought of, but this possibility has been high on the



TURBINE WHEEL of the four lifting RB.108 engines crowd the dimensions of this fuselage bay on the Short SC. 1 Note the angled bulkhead at the left of the picture to allow the gimbaled engines to swing through 30 deg.

list of expected problems with VTOL aircraft ever since engineers began studying them.

Foreign object ingestion, a major cause of premature turbojet engine removal, is particularly serious in case of VTOL designs where lifting jets impinge directly on the runway or takeoff area. This is one reason for the high intake stack on the Saunders-Roe Hovercraft (AW June 29, p. 64). It is also the major reason most of this type of aircraft use special "hard" takeoff areas.

Ground crews, working into the night, pulled the engines and checked them and the airframe for possible damage. Plane was cleared for flight again late in the evening two days later after most of the Farnborough crowd had gone home.

The plane stood on a special platform this time, and the ground around it had been well watered before Brooke-Smith started the four RB.108 lift engines. He ran them up to full thrust and the SC.1 bucked a little on its long shock struts, stretched and lifted off a few inches. Satisfied, Brooke-Smith cut the engines and terminated the test.

First complete public demonstration the following day was a success. He lifted the plane off vertically from its platform over the unused runway, and with all five engines thrusting, flew at slow speed over the runway to a spot in front of the SBAC president's tent, where he made the transition back into hovering flight. A third transition to forward flight again followed and then he eased the SC.1 back to its platform and down.

These brief demonstrations pointed up both the problems and progress with this unusual plane, which has been on flight status for more than two years now. The over-all program is one of basic research, with emphasis on the problems of low-speed and transition flight.

Short SC.1 is a test vehicle designed to develop the idea of a VTOL airplane using a group of powerplants for lift and a second powerplant for thrust. Lifting thrust comes from four Rolls-Royce RB.108 engines, gimbal-mounted in pairs to swing 30 deg. in a fore-and-aft plane. Each engine is rated at 2,010 lb. thrust, and supplies bleed air for operation of the low speed reaction control system. Powerplants were designed for a very high thrust-weight ratio and for rapid response to throttle motion.

A fifth RB.108 engine is mounted horizontally for forward thrust during the level flight phase.

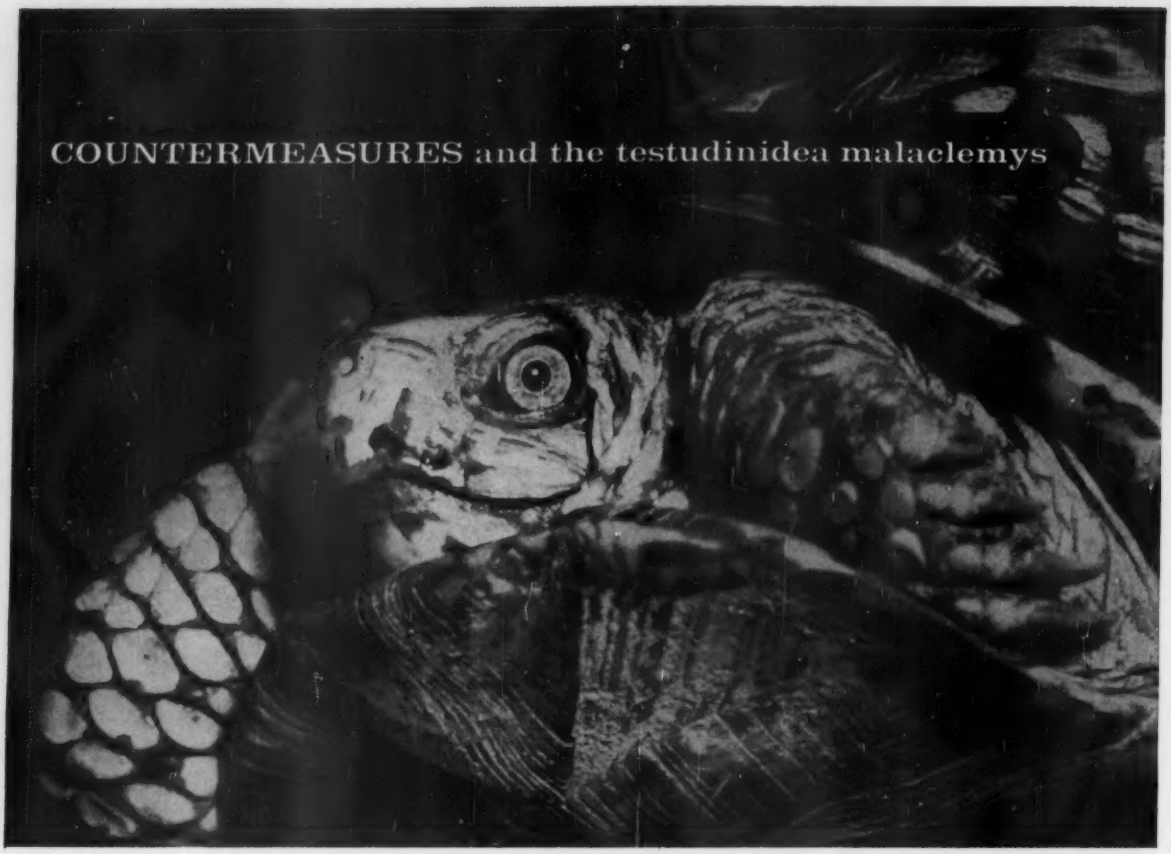
Air intake for the four lift engines is a screen on the fuselage top; the single forward-thrust engine is fed from a dorsal inlet through conventional ducting.

The airplane itself is a delta-winged layout with no horizontal tail. Wingspan of the SC.1 is 23 ft. 6 in., and over-all length is 24 ft. 5 in. The four lift engines are mounted near the center of gravity. For the low-speed flight regime, aerodynamic controls are inadequate and have been replaced on the SC.1 by reaction jets mounted under the nose and tail of the fuselage and near each wingtip.

Reaction Jets

Air for these reaction jets comes from all five engines; air bled from the compressors is fed into a common duct which in turn feeds the separate nozzles of the control system. Amount of thrust is controlled by the automatic stabilization system built into the airplane.

In vertical takeoff, all four lift engines supply the direct lift; once the plane is airborne and the fifth engine is running as well, the four can be tilted aft to give a forward component to their vertical thrust to aid the transition from hovering to forward flight. For the reverse situation the engines can be tilted forward to give a rearward compo-

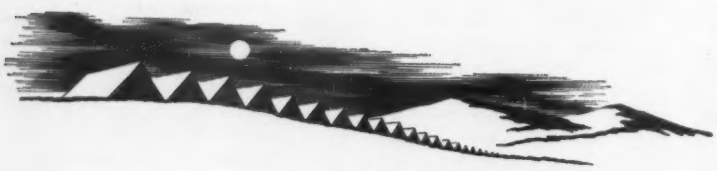


FORTUNATE, INDEED, IS THE TURTLE

for he carries his countermeasure right on his back...

Man on the other hand must devise his own countermeasures if he intends to survive in this day of modern warfare. Instruments For Industry is actively engaged in this field working in close conjunction with the Army, Navy, Marines and Air Force.

Recently developed is a portable unit which, in effect, places a "ceiling of safety" over personnel in the field making them all but invulnerable to ballistic attack. I.F.I. is proud of this opportunity to contribute to the defense of our services.



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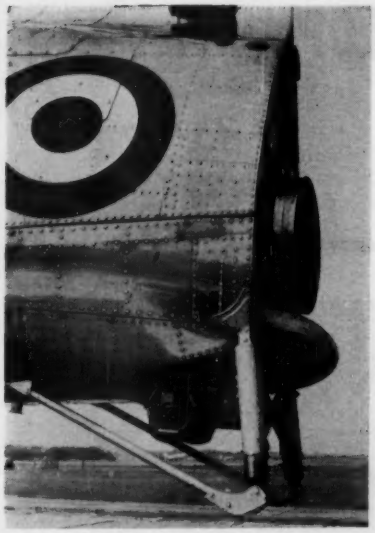


FUSELAGE REAR of the SC.1 shows reaction control jet system surrounded by tail bumper to protect the mechanism during conventional airplane landings.

nent to decelerate the plane to make the transition back to hovering.

Flight testing the plane was a varied program. It has flown as a conventional aircraft on the power of its single thrust engine and the lift from its wings, as well as in the vertical phase on lifting thrust alone.

Currently the major portion of the flight test program is devoted to the study of the transition phase from vertical to horizontal and back again.

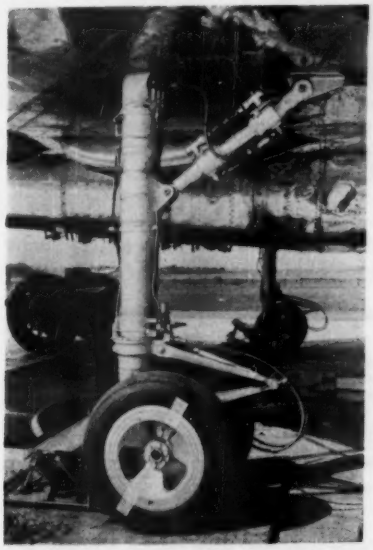
With this experience well under way, Short design teams began thinking of the possibilities of VTOL designs. One of these is a study for a fighter, using eight engines in two bays of four each as lifting engines, and a single turbofan engine for forward thrust. Such a design calculates to have a sea-level speed of Mach 0.98, would be supersonic at altitude, and should be able to carry a ton of weapons over a 250-mi. low-level radius of action.

Contract for the entire design, development, construction and flight testing of the SC. 1 (formerly the P.D. 11) was given to Short Bros. and Harland, Ltd. of Belfast. Taxi tests began in December, 1956, and by April the following year the airplane had been cleared for its first flight. This was made in a conventional sense like any other airplane.

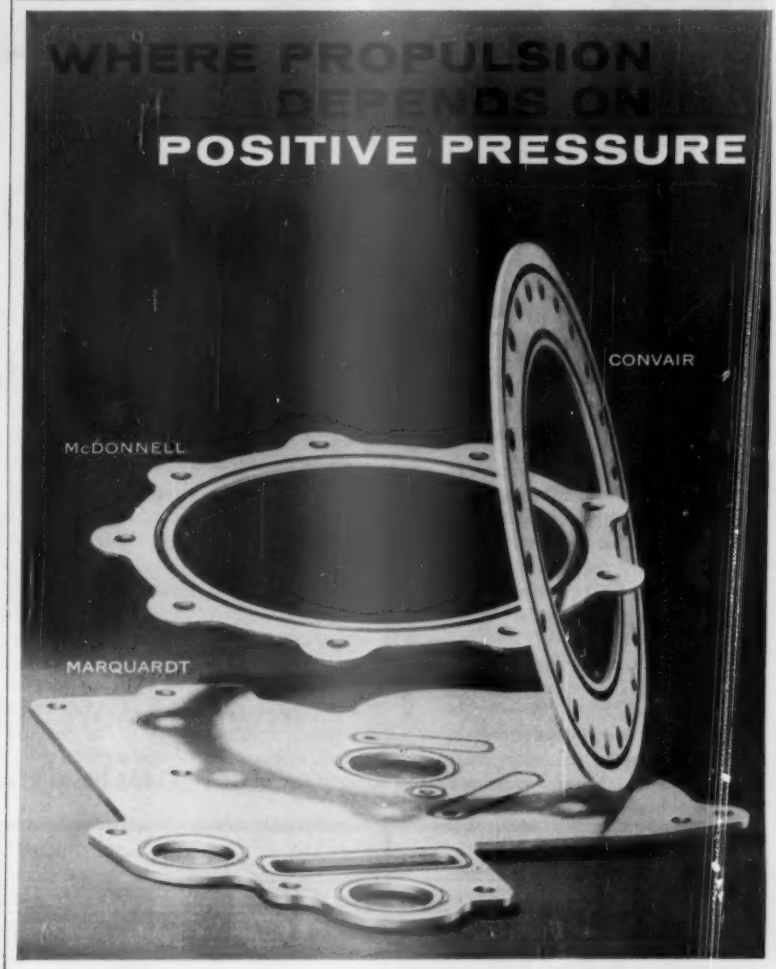
VTOL Flights

Vertical flights began in a gantry rig, with safety cables, about one year later in May, 1958. Hovering tests in the gantry began two months later.

The SC.1 demonstrated at Farnborough, carrying registration XG 905, was the second prototype. First prototype was being modified at the factory to make it meet current specifications



MAIN LANDING GEAR of Short SC. 1 can be rotated about attachment point to wing structure to vary the ground attitude of the airplane. For VTOL operations, ground angle is very low; for conventional takeoffs and landings, the ground angle is increased to make more lift available from the plane's delta wing.



Stillman meets "Space Age" requirements with the same reliability and product perfection that has earned them a name for dependability throughout the aircraft and missile industry for many years. Stillman products fly with the jets. They are also integral parts of the fuel and hydraulic systems for many of the advanced weapon systems. Engineering, research and development, and progressive designing enable Stillman to meet the challenge of the space age.

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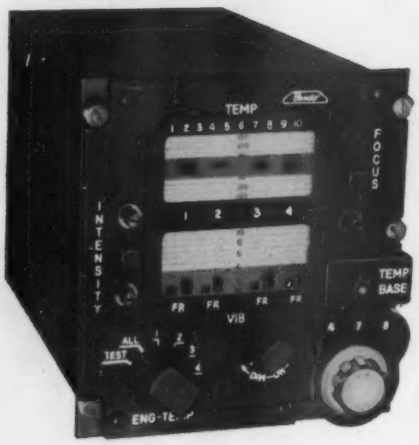

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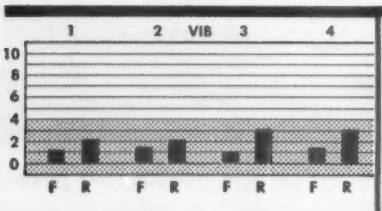
Provides a continuous condensed display of turbine engine vibration and temperature conditions

A landmark in engine instrumentation progress is the Bendix* Temperature-Vibration Monitor which simultaneously displays the findings of 40 temperature and 8 vibration sensors strategically located on all 4 engines of a turbine powered aircraft. This data is presented on the flight deck of the aircraft in bar graph form so that it can be continuously monitored and easily read.

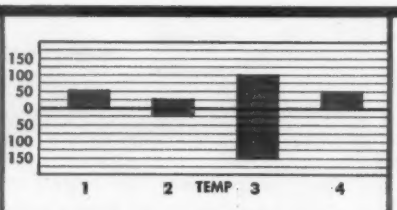
The average displacement of 8 vibration pickups is displayed continuously on the lower cathode ray tube with the top of the bar graph indicating vibration displacement on the grid scale. This continuous monitoring of vibration immediately indicates excessive unbalance on the jet engine.

The temperature analysis normally associated with the exhaust gas thermocouples will locate faulty burners, bad combustion distribution and plugged nozzles or any unusual hot or cold conditions around the turbine engine exhaust. The temperature display in the "all" position presents maximum and minimum temperatures on the upper cathode ray tube continuously for the four engines as reference to a temperature datum set in by the operator. The individual engine temperatures can be displayed as 10 bar graphs whose deflection can be read on the tube scale as deflections above or below the temperature datum, and individual degrees may be accurately and easily read from the digital read-out dial.

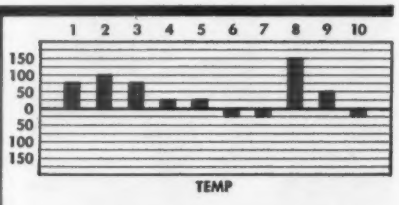
The equipment, initially developed for BOAC, is applicable to all airline and military turbine powered aircraft. The equipment for the four engine installation is approximately 30 lbs. and includes the Temperature-Vibration Monitor pictured above and a remotely mounted ½ ATR short box. *TRADEMARK



Vibration indication for four engines with front and rear pickups on each. Height of display indicates total vibration displacement.



Temperature "all" display indicating maximum and minimum temperatures above and below temperature datum for four engines.



Temperature for single engine indicates all thermocouples indicating temperature above or below temperature datum reference.

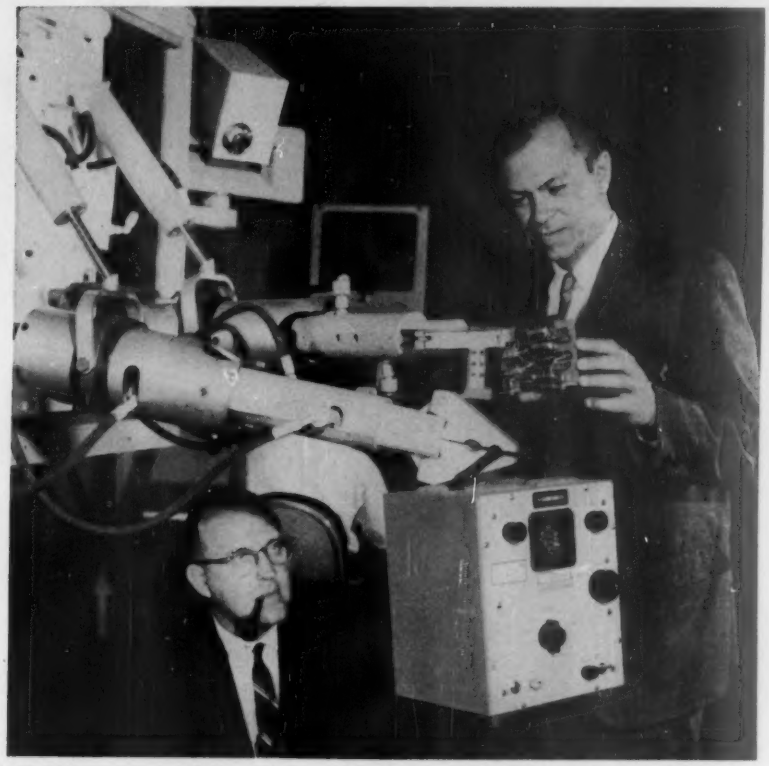
Scintilla Division
SIDNEY, NEW YORK

Bendix AVIATION CORPORATION

for the airplane. One major change made on the second prototype is the addition of a series of forward-facing cowl flaps which open at zero or low speeds in forward flight and help scoop air into the lifting engines.

One interesting feature is that the landing gear rotates about its attachment point in the wing to give two different ground angles. With the gear in its normal position for vertical takeoffs and landings, the airplane has a nearly zero angle of attack, and a slight angle of attack on the fuselage. With the gear rotated forward, the airplane assumes a nose-high attitude to give more available lift from the delta wing for conventional landings and takeoffs.

Data from this development program is being used by Short engineers to study civil aircraft proposals as well as military vehicles. No specific projects have been announced yet, and similarly, no further plans for development of the SC.1, either as a test vehicle or as a prototype, are known.



MOBOT remote controlled handling machine is inspected by Robert W. Henderson, left, Sandia Corp. president, and Dr. A. E. Puckett, Hughes vice president.

Mobile Handling Device Designed For Use in High Radiation Areas

Los Angeles—Mobile handling machine for radioactive materials handling in areas where radiation is too high for humans has been developed by Nuclear Electronics Laboratories of Hughes Aircraft Co.

Unit, called "Mobot," was developed for use by Sandia Corp. in its Sandia Engineering Reactor Facility, in which a "hot area" is used in radiation testing, rather than small individual cells. Mobot will be able to perform lifting, carrying by two arms, while the operator "sees" what he is doing through two television cameras mounted on the Mobot.

Machine will be able to perform work with certain hand tools, although very fine assembly and disassembly work still will be done with master-slave manipulators in front of windows, such as is currently done with hot cells.

In addition to being able to lift and carry test assemblies and specimens from place to place, Mobot will be able to perform such chores as decontamination of rooms and equipment. One result of using Mobot will be that reactor will have to be shut down only for maintenance.

Otherwise, usual reasons for shutdown such as refueling, changing specimens, will not apply since this work can be done with Mobot, the company said.

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How Lockheed-built satellites are

Making space travel safe for man

Before man can be sent into the emptiness of space, we must know how to protect him against the hazards of weightlessness and cosmic radiation—and how to bring him safely back to earth.

The United States is using every scientific means to solve these problems. The satellites in the Discoverer program of the Advanced Research Projects Agency—Lockheed-built Agena vehicles—are one of the means to achieve this end.

ARPA's Discoverer program is being executed by the Air Force's Ballistic Missile Division, ARDC. Lockheed's Missiles and Space Division is prime contractor and system manager of a team that includes Douglas, General Electric and Bell.

The Agena is by far the nation's largest satellite now in orbit—19 feet long, 5 feet in diameter. It weighs almost a ton when in orbit.

It was designed to be put into polar orbit—the most difficult of all to achieve. Four Agena satellites have been placed in completely successful polar orbits; more are on the way.

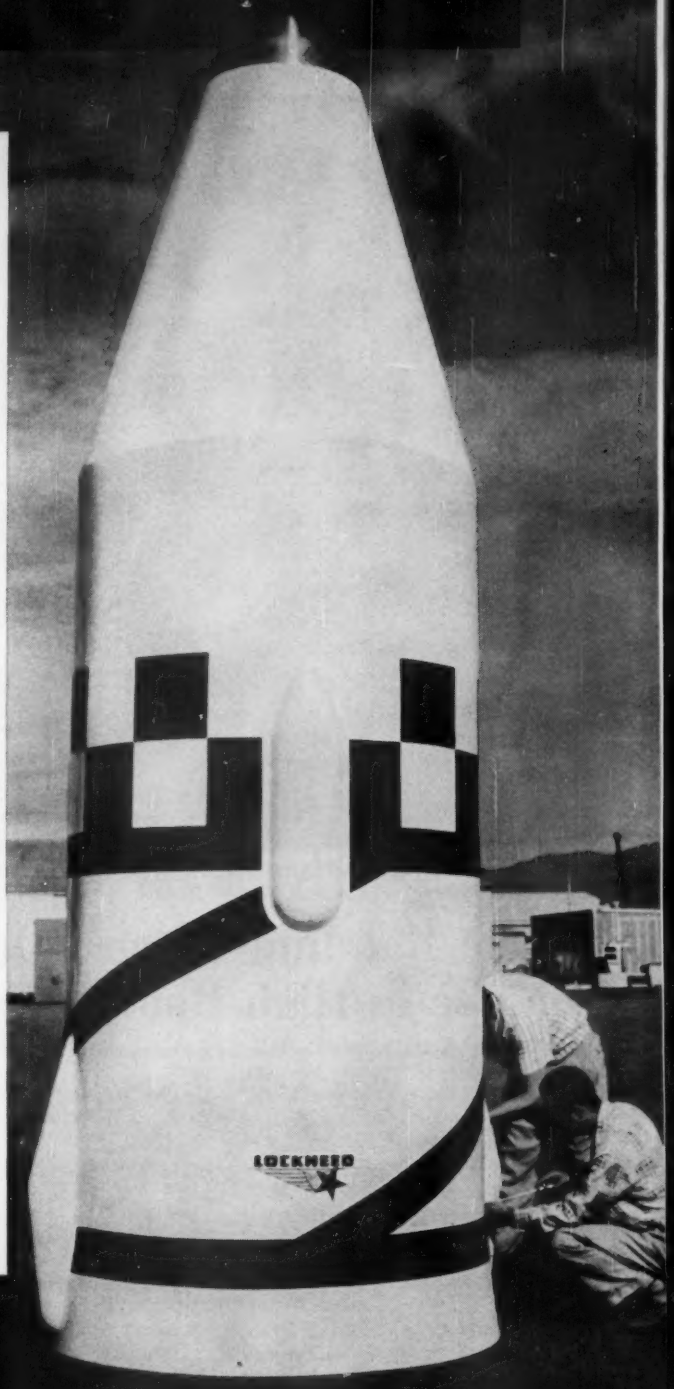
As it circles the globe every 90-odd minutes, the Agena radios home to its tracking stations more than a hundred measurements of the space phenomena it encounters and monitors its own performance.

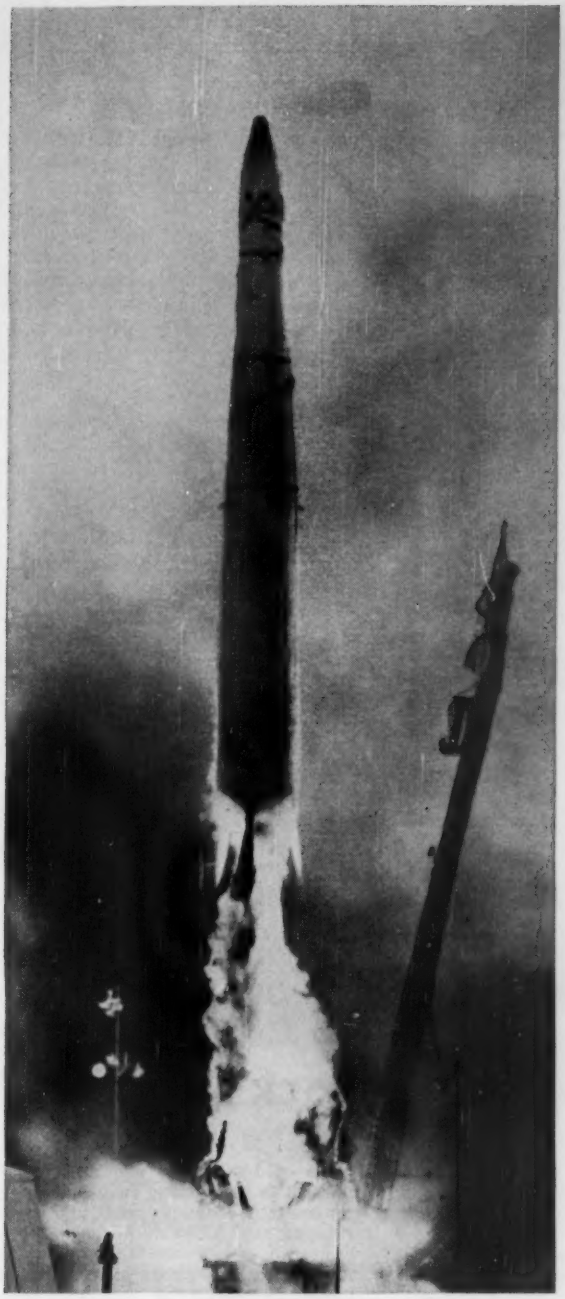
Trickiest part of the job is recovering the space capsule. Most satellites tumble and twist as they hurtle through their orbits at about 18,000 miles an hour. The Agena can stabilize itself on orbit and position itself at the exact 60° angle to earth that's necessary to separate the re-entry capsule.

The capsule's retro-rocket slows it to safe speed for re-entry, then drops away. A parachute floats the capsule earthward for aerial recovery by specially modified planes.

Each time an Agena satellite is launched, manned space travel comes closer to reality.

Agena satellite is America's most advanced orbital vehicle today—first in the world to achieve a polar orbit. Agena's nose section contains a combined re-entry vehicle and recovery capsule.





Boosted into space by the 150,000-pound thrust of an Air Force Thor missile, the second-stage Agena satellite is powered into orbit by its own liquid-fuel rocket engine of 15,000 pounds thrust.

Once in orbit, the Agena satellite radios back to its tracking stations more than a hundred measurements of its performance and of the conditions it encounters as it circles the earth at 18,000 mph.

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Where can you use this versatile HI-SHOCK SWITCH?

Military; missiles, mines, shipboard antennas, or industrial and commercial equipment wherever rigorous vibration, shock or constant acceleration is present, this new Hi-Shock Switch offers distinct advantages.

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Positive Stopping, Positive Locking. The ratchet mechanism prevents overshooting of the switch contacts—which will not move except during actual stepping. This mechanism is simple, reliable, virtually fatigue-proof.

Knife-Edge Contacts. On rotary switch contacts are strong and simple, provide positive connections to prevent chattering under acceleration and other vibration-producting conditions.

Environmental Ratings. The Hi-Shock Switch withstands non-operating impacts of 1000 g for one millisecond parallel to its rotating axis, and 100 g for one millisecond perpendicular to its rotating axis. The stepping switch operates under vibration, in three mutually perpendicular axis, of 0.5″ double amplitude 5—17.5 cps., and 10 g 17.5—2000 cps. Constant operating acceleration may be as high as 100 g, in axis parallel to rotation. Operating temperature range may exceed —65°F. and +165°F., and could be extended under special conditions.

Other models also developed with varying configurations and contact arrangements with higher current rating. Write for complete details. *Hi-Shock, Singer Military Products Division, Singer-Bridgeport, 915 Pembroke Street, Bridgeport 8, Conn.*

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A DIVISION OF THE SINGER MANUFACTURING COMPANY
915 Pembroke Street Bridgeport 8, Conn.

Epoxies Win Favor In Short-Run Tooling

Cambridge, Mass.—Aircraft and missile makers, facing high tooling costs and short production runs, are slashing fabrication costs 70% and more through use of plastic tooling.

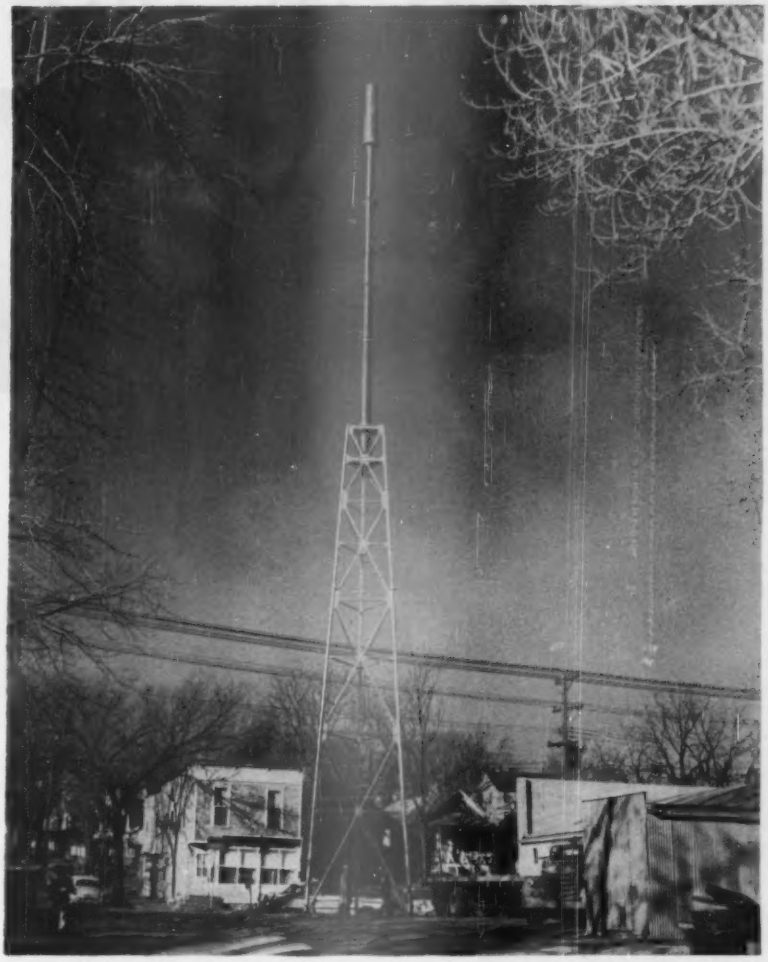
Favored tooling resins, according to a study carried out at the Harvard University Graduate School of Business Administration, are the epoxies, a versatile group of plastics that are also proving their merit to the aviation industry in structural laminates, adhesives, coatings and encapsulating agents.

The study is: Epoxy Resins: Market Survey and Users' Reference, published by Material Research, Box 363, Cambridge 39, Mass., @ $18.50.

Survey of several large aircraft companies showed that more than 20% of their tooling today is plastic and that 90% of the plastics are epoxies. One company which spent $5,000 for epoxy tooling in 1953 reported that it spent $100,000 in 1958. The use of epoxy tooling in the aircraft industry, reports the Harvard study, is growing 15-20% a year.

Primary reason for this rapid growth is not that epoxies are getting noticeably stronger but rather that production runs in the aircraft and missile business are getting shorter. Comparatively short operating life of plastic tooling is, in many instances, now proving long enough for the job at hand.

Along with the anticipated increase in plastic tooling, the study states, the over-all use of epoxies in the aviation industry will also continue to grow. In structural laminates and in adhesives, the growth rate is expected to match or even better that in tooling. Gains in epoxy coatings and encapsulating agents will be more limited.



PROTOTYPE self-supporting SAGE radar tower offers another promising aviation outlet for epoxy plastics. The tower, 110 ft. tall, is made up of a 60-ft. aluminum truss base, a 45-ft. glass fiber-reinforced epoxy monotube (recessed 5 ft. into the aluminum base), and a 10-ft. glass fiber-reinforced epoxy radome which completely encloses the head of the AS-505 antenna. The plastic monotube serves to eliminate signal interference between the metal base and the antenna. In operation, the weather-resistant epoxy radome, which also serves as a shipping container for the antenna, is pressurized as an additional safeguard against the entrance of moist air which could cause antenna burn-out. Air Force has ordered 45 of the radomes from Redman Pattern Works, Kansas City.

Largest User

Today, the aviation industry stands as the largest user of epoxy formulations for non-coating applications, and tooling is unquestionably the largest aviation outlet for epoxies, accounting for over 50% of the total usage in the industry. Slightly higher priced than the polyester and phenolic plastics, epoxies are generally preferred for tooling because of their dimensional stability and good strength properties. Use of epoxy tooling systems with their low shrinkage properties means that aircraft companies now can cast intricately shaped dies in less time and for less money than with the usual steel dies.

Lower cost of the epoxy tooling stems primarily from the reduced amount of finishing labor required—not from savings on materials, which may actually cost more than a comparable steel die.

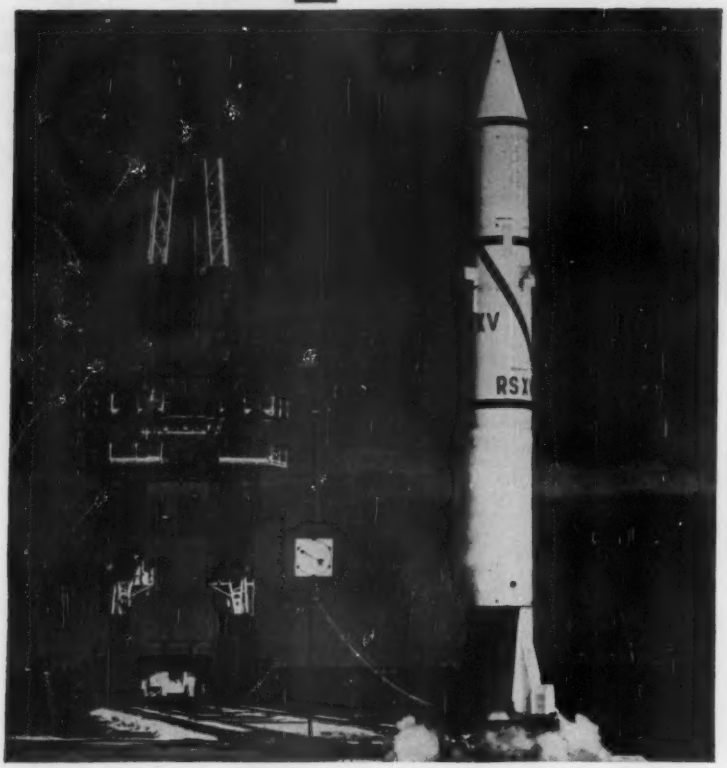
As an example of this, the authors make the following cost comparison of drop hammer dies based on data drawn from McDonnell Aircraft Co., showing how the company saved 70% by going to an epoxy die:

	Steel Die	Epoxy Die
Materials		
Steel core	$80	$80
Epoxy compound for cap	..	5
Labor and overhead	1,120	280
Total	$1,200	$365

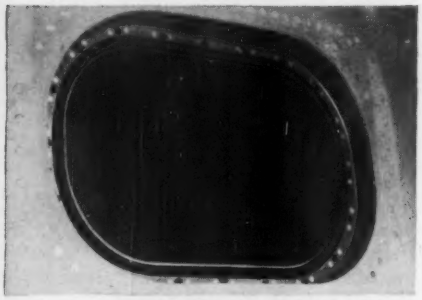
Another important advantage of epoxy tools is their light weight. Many large tools made out of heavy metal require a crane to move them, while their epoxy counterparts can be lifted and moved by only a few men. One company that changed from a steel jig to an epoxy jig eliminated the need for the counterbalance used with the steel jig, eliminated the service of one man on the operation and increased production by 100%. Because more plastic dies can be stored in a given area before reaching the floor load limit, a significant amount of storage space can be saved. High resistance to weather and corrosion of the epoxy tools also per-

SILICONE NEWS from Dow Corning

Semper Flexibilis



Sealing the nose cone on the Army Redstone is an extrusion of Silastic. Silastic maintains a positive seal despite long periods of storage under load and adverse operating temperatures.



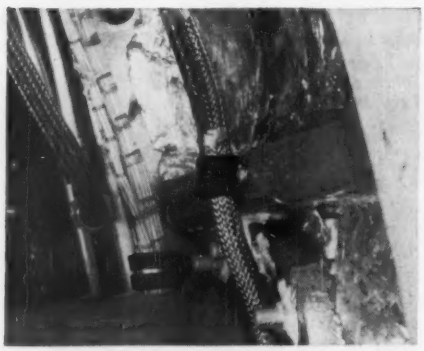
A similar application for Silastic, this time on the Army-developed Jupiter IRBM, another Chrysler-produced missile, is the seal on the angle-of-attack transducer compartment. Silastic was specified because it resists high temperatures encountered in re-entry.

SILASTIC seals missile sections; withstands -130 to 500 F

Till the moment when it separates during trajectory, the Army Redstone's warhead sits on a flexible seal of Silastic®, the Dow Corning silicone rubber. In fact, all sections of the missile are joined in this manner, to maintain pressure. Chrysler Missile Division engineers also utilize Silastic for many other applications, including ducting, wire bundle clamps and access door seals.

Silastic does these jobs so well because it offers reliability at all times . . . remains flexible even after long storage, at high skin temperatures, under compressive loads, in presence of ozone, cold, moisture. It is unaffected by weathering: 9 years exposure at a South Florida test station has failed to damage sample Silastic parts.

When your "bird is in the hole" and exposed to an environment of weathering, ozone, storage effects and a wide temperature range, you want reliability of rubber parts. Your rubber company supplier can engineer a part made of Silastic to suit your particular requirements. For more information, write Dept. 0922A.



Chrysler Missile Standard Bundle clamps on both Redstone and Jupiter missiles are fabricated of Silastic. Electrical properties of this material are excellent.

If you consider *all* the properties of a silicone rubber, you'll *specify Silastic.*

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.

Epoxy Metal Sandwich Bond Data

TEST	RESULTS	REQUIRED BY SPECIFICATION MIL-A-25463, TYPE I
Normal Temperature Peel	21.8 in.lb./in.	8.5 in.lb./in. (min.)
180F Peel	21.5 in.lb./in.	5.0 in.lb./in. (min.)
−67F Peel	7.2 in.lb./in.	2.0 in.lb./in. (min.)
Normal Temperature Flatwise Tension	1,500 psi.	450 psi. (min.)
180F Flatwise Tension	940 psi.	270 psi. (min.)
−67F Flatwise Tension	1,250 psi.	350 psi. (min.)
Normal Temperature Flexural	2,610 lb.	1,750 lb. (min.)
180F Flexural	2,540 lb.	1,200 lb. (min.)
−67F Flexural	2,620 lb.	1,750 lb. (min.)
Flexural After 15 days Exposure to 100% Relative Humidity at 165F	2,740 lb.	1,500 lb. (min.)
Flexural After 30 Days Exposure to Salt Spray (QQ-M-151)	2,510 lb.	1,500 lb. (min.)
Flexural After 30 Days Immersion in Hydrocarbon Fluid MIL-H-3136, Type II	2,570 lb.	1,500 lb. (min.)
Creep Deflection After 800 lb. Loading for Four hours at 180F	0.004 in.	0.100 in. (max.)

Based on North American Aviation data.

mits them to be stored outside for extended periods.

Most of the epoxy used in aviation tooling goes into dies having complex contours because it is here that the epoxies provide the biggest saving over machined metal dies. Often, metal inserts are used in those areas of an epoxy die which are subject to extreme wear.

Specific Examples

Specific examples of epoxy tooling for the aviation industry listed in the Harvard report include the following:

- **Prototype or development draw dies** for deep draws of heavy metals and for large compound-contour stampings of stainless steel up to ¼-in. thick.
- **Low production draw dies** for runs of 1,000 to 10,000 stampings.
- **Medium production draw dies** for 10,000 to 50,000 stampings in which metal inserts, draw rings and blank holders are used to strengthen the epoxy die.
- **Medium-high production draw dies** for 50,000 or more stampings of the thinner and more easily formed metals such as .025 in. brass.
- **Flanging, trimming,** re-strike, and secondary operational dies.
- **Hydroform and rubber pad** forming dies in which epoxies can be used to make large castings and provide abrasion-resistant surfaces that will not scratch soft aluminum or other metals.
- **Stretch dies** with sharp radii.
- **Fixtures and gages** where the application requires mass casts for rigidity or where the epoxies' heat and abrasion resistance make them more suitable than other materials.

Aviation industry's use of epoxies for structural laminates is increasing but still trails that of the lower priced polyester resins. In one Sikorsky helicopter, the number of laminated plastic parts has increased from four in 1955 to 200 at present, with epoxies accounting for much of the increase. McDonnell Aircraft is using epoxy laminates for radomes, wing tips and antenna windows, among other applications. (For a business flying manufacturer see p. 112.)

Convair is using epoxy laminates for non-structural decorative and acoustical panels in its new jet transports because of the weight savings over conventional materials. Compared with other plastic laminates, the epoxies also show up favorably in suitability for Type I pneumatic system ducts. As adhesives, epoxies are proving attractive to the aviation industry primarily because of their good, versatile and well balanced bonding properties. Epoxies, according to the Harvard report, are excellent structural bonding agents for aluminum, steel, glass, and wood, as well as for reinforced polyester, epoxy, phenolic and melamine resins.

North American Aviation, with experience gained from the fabrication of over 150,000 epoxy-bonded primary and secondary aircraft structures, reports the epoxies have several advantages over most common bonding systems. First, they are relatively insensitive to normal variations in ambient temperature and so require no expensive atmospheric control during adhesive preparation and assembly. Their suitability for both metal-to-metal and metal sandwich bonding eliminates the need for more than one basic adhesive and for multiple cures in the fabrication of complex bonded assemblies.

Epoxy adhesive systems are also unusual in that they have both high peel strength and elevated temperature creep resistance. In metal-to-metal bond data developed by North American Aviation, lap shear values of epoxy bonded systems exceeded 3,000 psi. regardless of exposure conditions and test temperatures (which ran from −67F to 180F). Curing agent used by North American Aviation to obtain optimum strength over the −67F to 180F range was an aliphatic amine. To extend the temperature resistance of epoxy adhesives to 260F (intermittently to 300F), a diamine curing agent is used.

Another point made by the Harvard report is the unusually high reliability of epoxy bonds. Noticeable variations in catalyst content, glue line thickness,

Epoxy Metal-to-Metal Bond Data

TEST	RESULTS	REQUIRED BY SPECIFICATION MIL-A-5090B
Standard Temperature Shear Strength	3,770 psi.	2,500 psi. (min.)
180F Shear Strength	3,366 psi.	1,250 psi. (min.)
−67F Shear Strength	3,173 psi.	2,500 psi. (min.)
Standard Temperature Creep-Rupture Strength (Deformation)	No failures 0.0008 in.	0.015 in. (max.)
180F Creep-Rupture Strength (Deformation)	No failures 0.0005 in.	0.015 in. (max.)
Standard Temperature Bend Strength	189 lb.	150 lb. (min.)
30 Day Salt Spray Shear Strength	3,210 psi.	2,250 psi. (min.)
30 Day Water Immersion Shear Strength	3,200 psi.	2,250 psi. (min.)
7 Day Immersion in Anti-Icing Fluid	3,739 psi.	2,250 psi. (min.)
7 Day Immersion in Hydraulic Fluid	3,754 psi.	2,250 psi. (min.)
7 Day Immersion in JP-4	3,654 psi.	2,250 psi. (min.)
7 Day Immersion in Hydrocarbon Fluid	3,834 psi.	2,250 psi. (min.)

Based on North American Aviation data.

JET ENGINE SUPPRESSOR

WITHSTANDS SUPERSONIC SHOCK

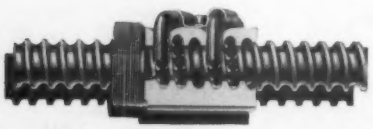
BUTTRESSED BY THE Saginaw b/b Screw

Suppressor in use behind an Air Force F-86 H "Sabrejet"

Muting the ear-shattering roar of a jet engine on pre-flight "run-ups" is the job of Koppers Company, Inc.'s new Portable Run-Up Suppressor. And four Saginaw Ball Bearing Screws—flanking the body of the Suppressor—help hold it rock-steady against the full force of the jet engine's supersonic blast!

These Saginaw b/b Screws enable the Suppressor to be hand-raised or lowered into position faster and with far less effort than by any other manual means. The reason? The Saginaw b/b Screw converts *rotary* motion into *linear* motion with over 90% *efficiency!* And the dependable Saginaw Screw also played a significant part in keeping the Suppressor both light in weight and portable in design.

Whether you manufacture miniature electronic controls or giant production equipment, the Saginaw b/b Screw may be able to give *your* products that valuable **S**ales **A**ppeal you're looking for. To discover all the benefits it can bring you, write or telephone Saginaw Steering Gear Division, General Motors Corporation, Saginaw, Michigan—*world's largest producers of b/b screws and splines.*



Give your products NEW SALES APPEAL... switch to the Saginaw ball bearing Screw

WORLD'S MOST EFFICIENT ACTUATION DEVICE

bonding pressure and even contamination by an oily sweeping compound have little or no apparent effect on bond strength.

Good dielectric and mechanical properties have made epoxy resins desirable encapsulating agents for airborne electronic components (AW Sept. 28, p. 111). This is an important aviation application for epoxies though comparatively small in terms of the resin volume required. Another small but interesting use of epoxies is in aerodynamic fairings.

Coating Applications

To some extent, epoxies are also used in aircraft coating applications, where they are serviceable to approximately 400F.

One aircraft company, for example, coats magnesium castings used in a fuel vent system with epoxies to prevent corrosion.

The strong adherence of epoxies—considered highly desirable in bonding applications—is, however, regarded as a serious drawback in aircraft coatings which may have to be stripped for maintenance reasons.

PRODUCTION BRIEFING

Bristol Aircraft, Ltd.'s latest diversification move is a contract with Lotus Engineering, Ltd., Waltham Cross, England, to supply glass fiber bodies for the Lotus Elite sports car. Production, by Bristol's Plastics Department, is expected to reach 25 units per month.

Kollsman Instrument Corp., Elmhurst, N. Y., will build automatic and semiautomatic testers for the Kollsman astro compass systems on Boeing B-52 bombers under a $12,105,000 Air Force contract. The automatic unit checks compass systems installed in aircraft, and the semiautomatic tester is used at maintenance depots.

Zenith Plastics Co., Gardena, Calif., will develop and produce bomb-navigation-missile guidance radomes for the North American B-70 under a $1 million contract from North American. Production will take place at the company's Gardena facility.

Westinghouse Electric Corp.'s aircraft equipment department, Lima, Ohio, has received a $250,000 contract to build static inverters for the Lockheed JetStar executive transport. Three of the inverters, rated at 3 kva., will be installed in each aircraft.

Lockheed Aircraft's Georgia Division has received a $5 million contract to convert 12 B-47 bombers to QB-47 pilotless drones for use in evaluating North American continental defense systems. Two QB-47 drones already are in flight test at Air Proving Ground Center, Eglin AFB, under a previous program. The 12 additional drones will be delivered to Eglin at the rate of one a month beginning next spring. The drones land and take off under ground control and are controlled in flight by director aircraft.

Purolator Products, Inc., Rahway, N. J., will produce 250 aviation filter designs for U. S. Air Force during 1960. The order, from the Directorate of Procurement and Production, Tinker AFB, Okla., cover more than 1.5 million units; contracts total $800,000.

Ferranti, Ltd., Edinburgh, Scotland, expanded its inertial guidance laboratory with a 17,500 sq. ft. addition. The new facility, an ultra-clean area, will be used to produce floated rate integrated gyros, built under license from Kearfott Co., and other inertial system components.

All American Engineering Co., Wilmington, Del., will develop the maintenance hoist system for the North American B-70 bomber under $50,000 Phase I contract from North American. System will employ All American's Model 61 electric winch, which weighs 50 lb., and hoists 4,500 lb.

"Ultraminiature Circuitry" from Texas Instruments Incorporated, Dallas.

Product of Dallas Brains in Electronics

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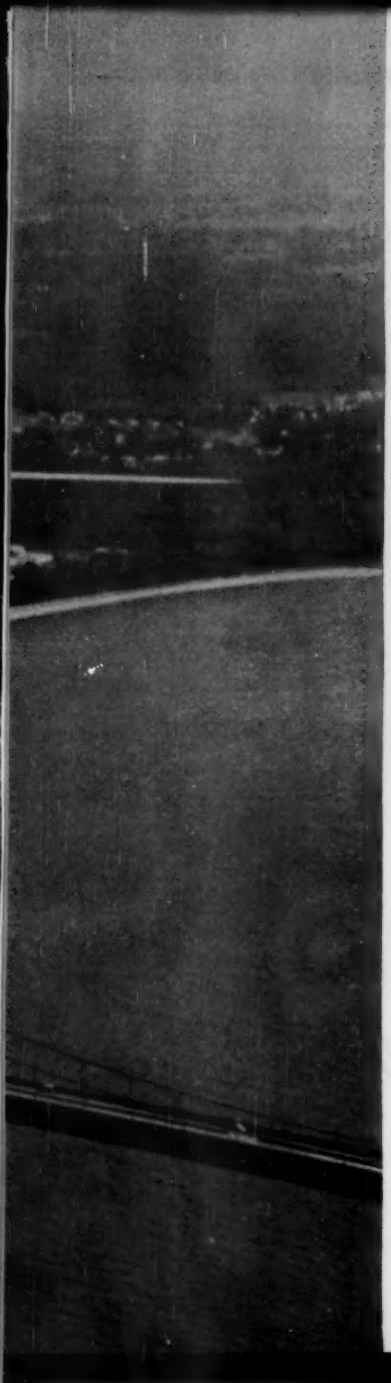
The four-ton H-16, first in Vertol's series of turbine-powered helicopters, flown in 1955.

The H-21D research aircraft equipped with two GE T-58 turbo-shaft engines, flown in 1957.

The Vertol 105 with two Lycoming T-53 engines used in the test programs, flown in 1957.



Why Vertol leads in turbine helicopter design and development

Steady progress in technology has advanced this versatile air vehicle, the helicopter, to the threshold of a new era of usefulness. It is the era of the turbine-powered transport helicopter designed for improved battlefield mobility and logistical support of combat elements and missile systems, and for all-weather, day-night operations in military or commercial service.

Vertol has been and is today at the forefront in progress toward this new achievement. Among the first to recognize that turbine power would vastly improve performance, capacity and versatility, Vertol also is a leader in research and development on new designs incorporating these powerplants.

The result of many years of work in this field is the Vertol 107, first member of an entirely new generation of multi-turbine helicopters destined to play vital roles in short-range transportation throughout the world. It is now being produced for the U. S. Army as the YHC-1A. The "107" can be adapted to an almost limitless variety of functions without altering basic design. Its built-in growth potentiality has already resulted in a decision by the U. S. Military to procure a larger, more powerful version of the 107 type from Vertol. This growth also assures a steady future progression of helicopters of greater performance, load-carrying ability and versatility.

In 1958 the Vertol 76, powered by the Lycoming T-53 was the world's first successful tilt-wing VTOL.

VERTOL Aircraft Corporation

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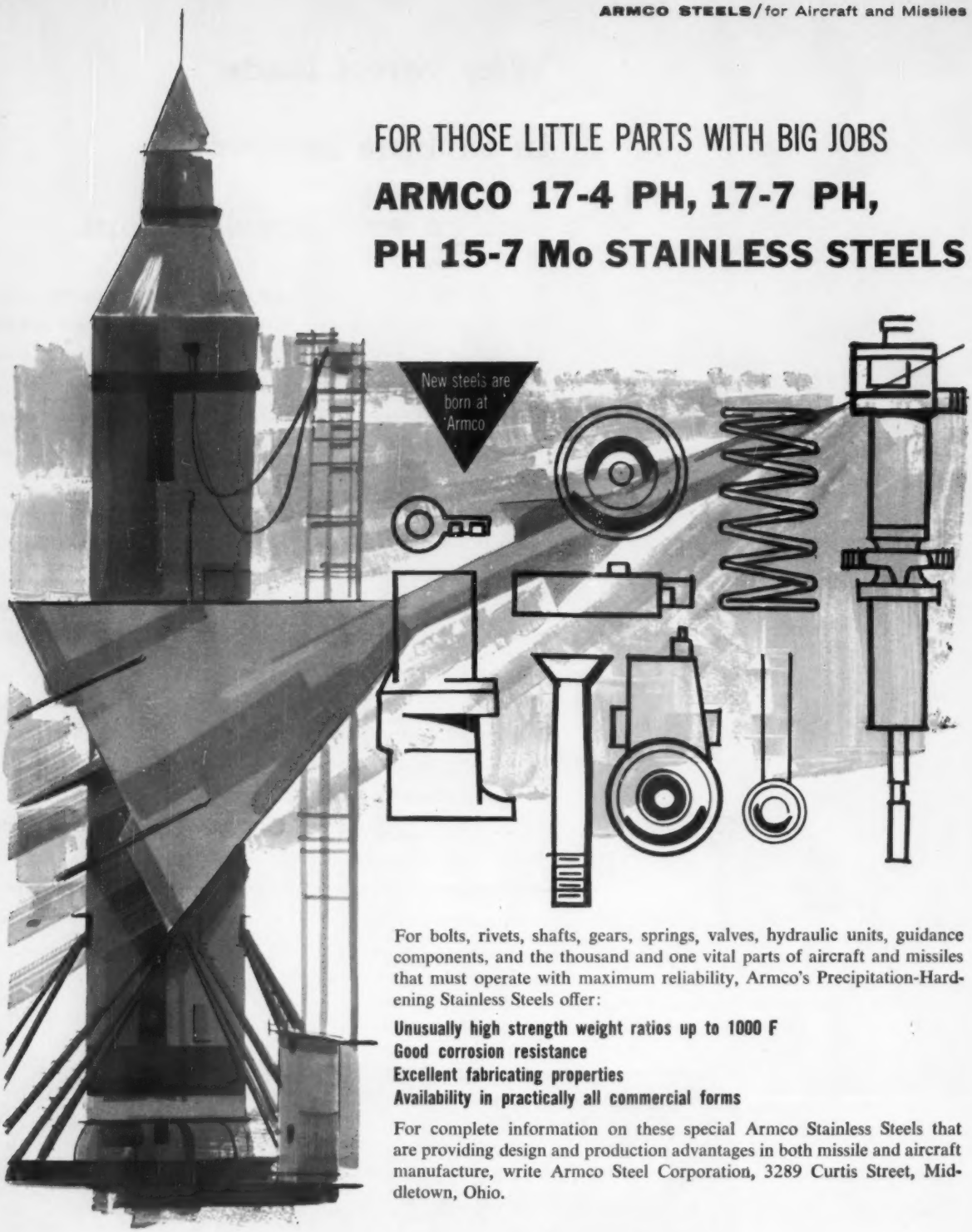

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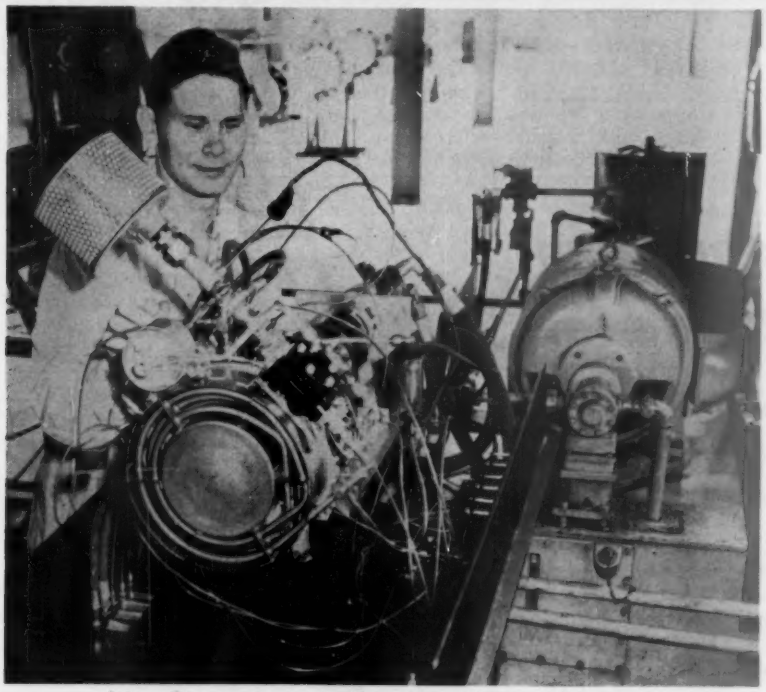

Air Compressor for Pershing Support

Air compressor delivers 12 cfm. at 3,000 psi. as part of the ground support equipment for the Army's Pershing solid propellant missile. Adaptable to electric or hydraulic motor drive, the four stage 90 deg. V-shape compressor was developed by Stratos Division of Fairchild Engine & Aircraft Corp. The 30 lb. unit is undergoing tests at the Research and Development Laboratories, Ft. Belvoir, Va.

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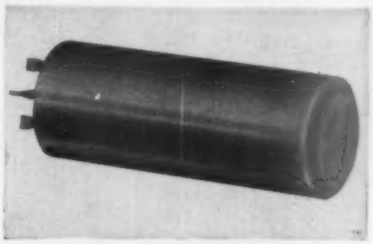
Angular force balance accelerometer measures pitch, roll and yaw accelerations in missile and aircraft flight dynamics. Another application is measuring wind gust loads on oscillating radar antennas.

The accelerometer acts as a subminiature servo system responsive to input angular acceleration about the sensitive axis. The basic accelerometer consists of a seismic system and associates a position-error detector, a restoring mechanism, and a servo error signal amplifier. All electronics and seismic systems are enclosed in a hermetically sealed dome 3.7 in. in diameter by 3.7 in. high which weighs 2 lb.

Donner Scientific Co., Concord, Calif.



Acceleration Integration Switch

Mechanical integrating switch functions as a product of acceleration and time in switching for arming warheads' programing missile control functions, and thrust control.

A normally closed monitoring switch signals the start of the integration process which at a given velocity, expressed as a product of g and time, closes a normally open switch. Operating ranges are 10 to 25 g-seconds over a detection input of 5-20g, with a maximum of 5 consecutive g inputs within a given range.

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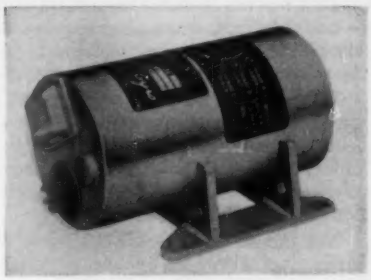
A synchronous hysteresis motor powers the rotor which is mounted on angular contact preloaded bearings. Raceways ground integral with the shaft



provide stiffness and life in excess of 1,000 hr. Variable reluctance microsysn pickoff with high signal-to-noise ratio measures the angular deflection. Damping coefficients can be readily varied over a wide range to meet individual specifications.

Whittaker Gyro Division, Telecomputing Corp., 16217 Lindbergh St., Van Nuys, Calif.

In-Line Pressure Switch

Pressure switch, designed for hydraulic, fuel and pneumatic systems, utilizes a piston-type pressure sensor.

Series 102000 pressure switch is unaffected by jarring or vibration. A compression point controls the point of actuation and may be adjusted externally to accommodate minor changes. Standard units with ¼ in. male pipe pressure connection and ½ in. male pipe electrical conduit connection are available from 50 to 3,500 psi. The 2 oz. valves are 3 in. long and will operate from −65 to +165F with an electrical rating of 15 amps at 120 v.d.c.

Fisher Controls Inc., 1928 Lincoln Blvd., Santa Monica, Calif.

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Infrared at ITT includes complete detection systems as well as basic components

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Moon Shot Indicates Soviet Guidance Gain

Los Angeles—Study of the orbit of Russia's successful lunar impact vehicle indicates that it probably had a substantially better guidance and control system than the earlier unsuccessful Mechta, Dr. Samuel Herrick of University of California-Los Angeles told AVIATION WEEK at a symposium on Frontiers of Science and Engineering cosponsored by the University and Institute of the Aeronautical Sciences.

Dr. Herrick, who is professor of astronomy and principal astrodynamicist for Aeronutronic Division of Ford Motor Co., said duration of the vehicle's flight indicates the Soviets did not use a trajectory offering some degree of automatic compensation for velocity errors as they did with Mechta. Velocity error compensation occurs in trajectories with a duration from about 32 to 34 hr. Duration of the Lunik flight was 38 hr. 15 min. from the moment of payload separation at an altitude of 44,741 mi.

More than 700 scientists and engineers heard Dr. Herrick discuss the mechanism of velocity compensation. For the proper range of velocities compensation is almost exact if the vehicle is orbiting about the earth in the same direction as the moon. If velocity is slightly low, tightest orbit curvature will occur earlier, causing the vehicle to intercept the moon track farther downstream. Increased time of flight to the moon track allows the moon to progress farther in its orbit, compensating for the error and establishing a new intercept point. Reverse compensation occurs if velocity is slightly high.

Dr. Herrick stressed the need for more effort to obtain data useful to space flight itself and suggested that projects designed to yield information for other applications be postponed.

Permanent Base

Dr. Herrick contended that the attempt to create a permanent lunar base should be made on the first manned flight to the moon as the ability to maintain a small lunar colony will be achieved earlier than the ability to make a round trip. Some loss of life can be expected, as in all pioneering and colonizing efforts on earth, he claimed.

Major problems in astromechanics cited by Dr. Herrick are those associated with spot landings on the moon and planets and with interception of vehicles in space, particularly in rescue operations. With present control techniques and understanding of the space environment it is impossible to guarantee a landing upon the moon within 100 mi. of a specific objective.

"Interception of satellites requires the most careful trajectory determination for several circumnavigations of the earth with the principal corrective thrust applied one-half period before contact," he said. In rescue missions, time available may be inadequate for this careful navigation.

Interplanetary vehicles using low thrust propulsion will require more precise navigation, rather than less precise, as has sometimes been assumed.

"In general, precision methods will both increase payloads and diminish costs whatever the state of the art of astromechanics may be," Dr. Herrick said. "In this area, we are engaged in a more subtle race with the Russians than that involving mere priority of landings on the moon or planets. This race will be a much closer contest than most, and its outcome will be a determining factor in the exploratory expeditions of the near future."

Progress in research with free radicals was attributed at least partly to the increased number of physicists working in the field by James W. Moyer of General Electric's Technical and Military Planning Operation. Moyer termed much of the optimism about the utility of free radicals as space vehicle propellants "almost irresponsible." However, a potential for storing large amounts of energy in a small package does exist, he said.

Two technological factors in recent advances are:

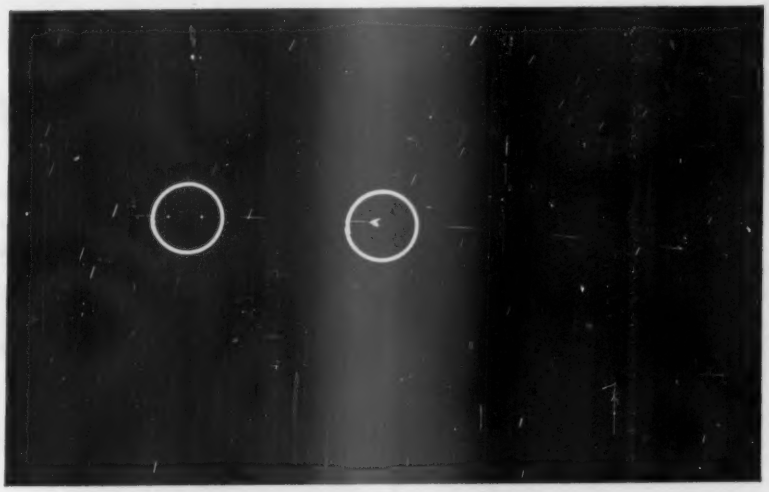
- **Electron spin resonance** research technique which is now being applied with well-engineered production equipment.
- **Greater ingenuity** in low temperature experiments and impressive improvements in experimental use of liquid helium and hydrogen.

Key research areas he listed were:

- **Diffusion and mobility** of free radical species as functions of environment and temperature.
- **Role of free radicals** in catalysis.
- **Exploration** of new chemical compounds.
- **Relation of heat transfer** and free radical transfer in combustion.
- **Development** of free radical thermodynamics or steady states of non-equilibrium systems.
- **Precise calculation** of optical and electron spin resonance spectra.
- **Further attempts** to stabilize metastable inert atoms and studies of how to recover energy in non-radiative transisions.

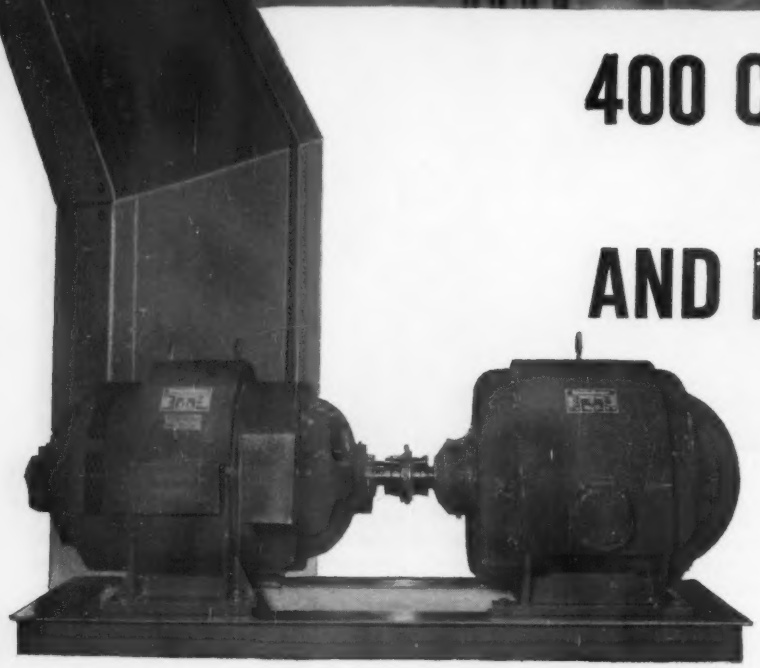
Production Problems

Moyer said that as much has been accomplished in the field of free radicals during the past five years as was accomplished in the preceding 30 years. He attributed this largely to the three-year program in free radicals run by Bureau of Standards which ended recently. Production problems yet to be solved deal with stabilization rather than formation of the radicals. Studies to date have not been oriented toward optimum proc-



Juno II Gives Bermuda Fix

Juno II rocket launched from Cape Canaveral Aug. 14 ejected two 35-million-candlepower flares after second stage fired 600 mi. above the Atlantic so ground cameras could triangulate for an accurate fix on Bermuda. The island's chart position was relocated 400 ft. Ballistic cameras at Langley AFB, Va., Otis AFB, Mass., and Bermuda tracked the missile, photographing the flares simultaneously on a remote signal from Canaveral. Reverse print shows Juno II second stage firing (right circle) and the two flares (left circle). Broken lines were added to show missile trajectory. Short streaks are star tracks.



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For precision testing of 400 cycle electronic assemblies, the new, exclusive Westinghouse high-frequency *bus duct* dry-type *transformers* and *central generator* system will power thousands of square feet of production and laboratory space efficiently and easily.

Westinghouse 400 cycle power systems are especially designed for use in laboratories, for production lines or operational areas, for radar sites, and for modern airport power facilities. Minimum voltage drop, low line impedance, and precise power supply are assured.

This new Westinghouse system has many advantages over cable/conduit or multiple M-G set methods.

- Provides economy and flexibility for installation, rearrangement and expansion.
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- Permits single and/or 3-phase load take-offs.
- Requires much less maintenance and provides greater overall plant efficiency.
- Saves space in power line runs and at test stations.
- Eliminates wave distortion from stray radio frequencies.

The 3- or 4-wire bus duct is available in re-usable sections up to 10 ft long. Plug-ins (up to four per 10-ft section) can be connected or disconnected instantly, without de-energizing the circuit. Angles, crossovers and offsets give complete flexibility for tight, space-saving installation. Simple section connectors permit easy separation for rerouting, modification and expansion.

The built-to-order, heavy-duty generator and 400 cycle dry-type distribution transformers are completely tested and matched with the duct installation to keep system-wide impedance and voltage drops at the lowest possible level. For example: at 200 amps—the voltage drop in 100 ft is only 0.625—not the 7—12 volts of other systems.

Take advantage of the Westinghouse ability to design and install a system of high-frequency power generation and distribution to fit your needs. Contact your local sales engineer or write: Westinghouse Electric Corporation, P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pennsylvania. J-92035

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esses or high efficiency. Some less energetic species, such as ethyl radicals, have been stored for many days at liquid nitrogen temperatures, but liquid helium temperatures will be needed to store nitrogen and hydrogen radicals.

Trends in the development of military aircraft were outlined in a report by Edward H. Heinemann, vice president, Engineering Combat Aircraft Systems, Douglas Aircraft Co. Heinemann pointed out that progress in military aircraft development must now be matched to what is practical rather than to what is possible. Technological advances have become possible, he said, which are not feasible economically because of declining interest in military aircraft.

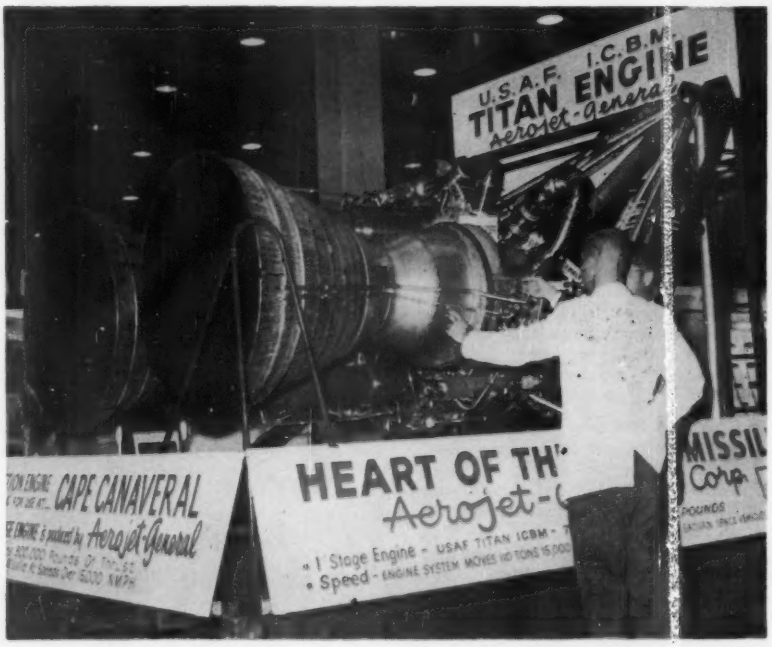
Heinemann noted that by 1960 weight of fighter aircraft will be approximately 100% over the 1945 average. Fighters now are under development which will weigh 300% of the 1945 figure. This trend reflects ever-increasing demands for more speed, range, and military loads and suggests a re-evaluation of the manned fighter aircraft mission, he added.

Significant trends can be noted in the way the weight breakdown of aircraft has varied since 1945. Structural weight has remained steady at somewhat over 30% of gross weight. Apparently, progress in materials and structural efficiency has exactly matched the penalty caused by thinner wings and sweepback for high speed flight. Proportionally, weight of powerplant and military load has steadily decreased. Military load reduction is largely the result of improvement in nuclear weapons.

Avionics fraction of military load has remained about constant—increase in avionics weight just keeping up with over-all weight trends. Heinemann said "further improvements in performance should not be made at the expense of increased aircraft attrition due to high landing speeds. This already is a major element in the defense cost picture."

Steadily increasing landing speeds have been accompanied by a trend toward higher landing accident rates. Emphasis on low speed performance is needed not only for safety but as a way of shortening runways requirements. Pure STOL aircraft would be provided for limited war situations.

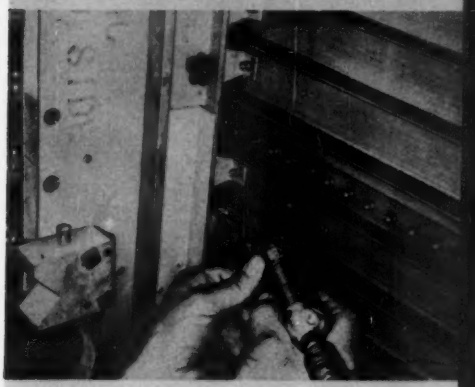
"Maximum application of conventional high lift devices such as full span slats, flaps, and such boundary layer control as may be obtained from engine bleed air will give considerably improved lift. A full scale attack on this problem utilizing very large quantities of flowing air for supercirculation could lead to further large gains. The system might require that a substantial portion of the wing volume be used for air ducts and large volumetric penalties would tend to offset the lift gains. Special air sources are also required. However, bypass or turbofan engines offer



Titan Engines Displayed for First Time

Two first-stage engines for the Air Force-Martin Titan intercontinental ballistic missile developed by Aerojet-General were publicly displayed for the first time at the Air Force Assn. annual convention in Miami Beach, Fla. Combined thrust of the engines is rated at 300,000 lb. by Aerojet-General.

THE HI-LOK AUTOMATIC FEED DRIVER, FITTED TO AN INGERSOLL-RAND AIR MOTOR, ASSEMBLES UP TO 200 COLLARS ONTO HI-LOK PINS WITHOUT RE-LOADING. ASSEMBLY RATE: UP TO 45 PER MINUTE.



HI-LOK IS BEING ASSEMBLED UNDER WING RIB IN EXTREMELY TIGHT QUARTERS USING A HI-LOK 20° RATCHET WRENCH ATTACHMENT AND KELLER AIR MOTOR.

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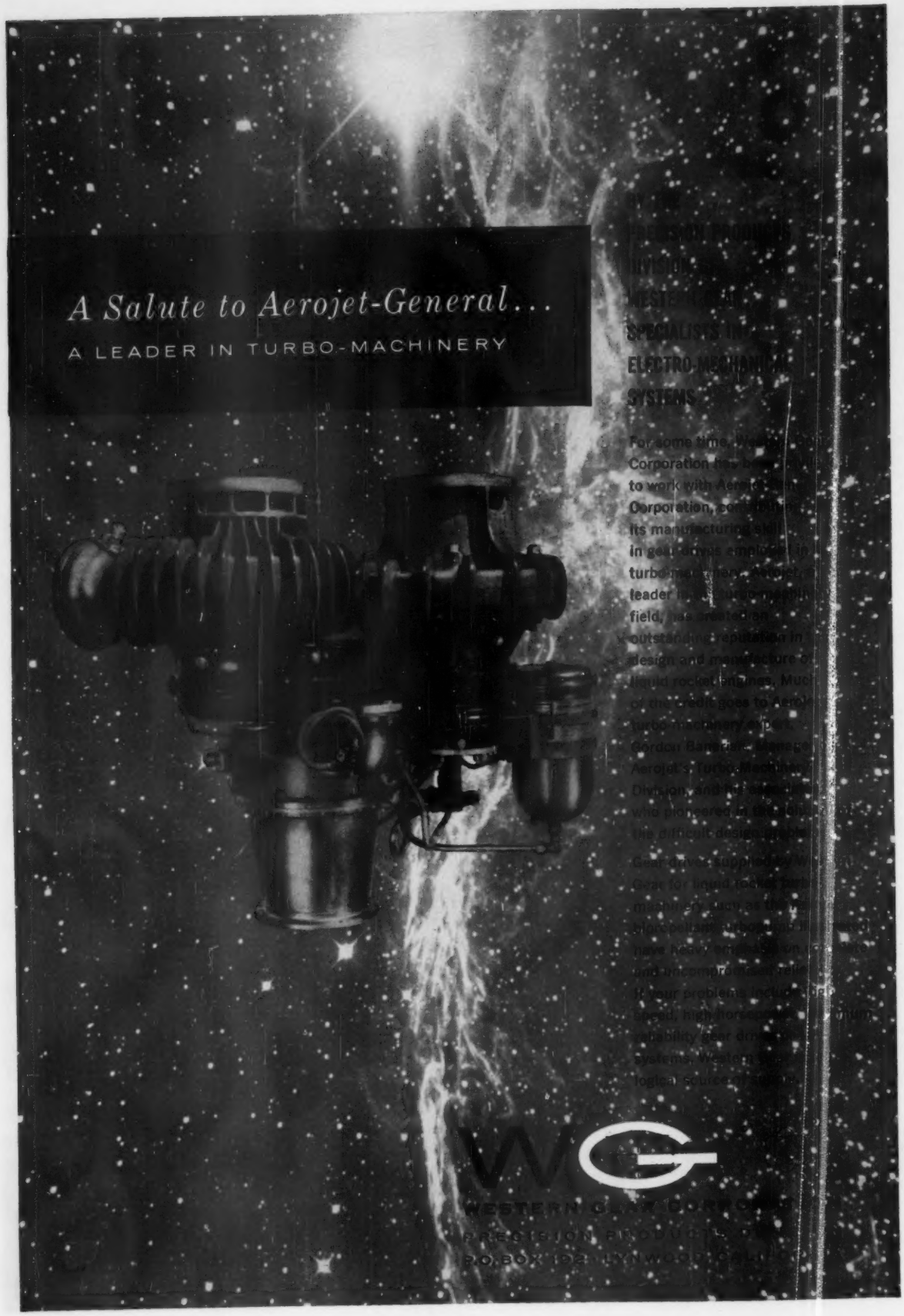
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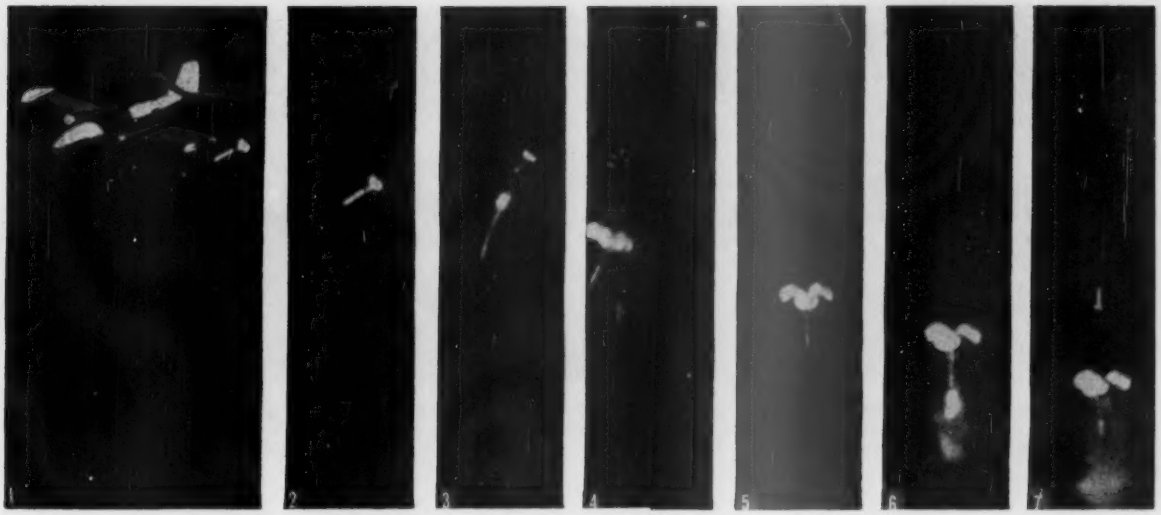


Sounding Rocket Ascends From Air-Dropped Launcher

Air Force weather sounding rocket designed to measure atmospheric conditions up to 200,000 ft. (AW Sept. 15, 1958, p. 34) is launched from the bomb bay of a Martin RB-57 at 20,000 ft. The rocket permits gathering of high-altitude weather data over geographical areas where ground launching of weather rockets or balloons is not feasible. Sequence shows: 1—launching; 2—deceleration as drag parachute is ejected; 3—deployment of three stabilization parachutes; 4 and 5—stabilization as open-end launcher tube hangs vertically beneath clover-leaf chute cluster; 6—ignition of rocket, and 7—ascent of sounding rocket through unobstructed opening between parachutes. Convair (Pomona) Division of General Dynamics Corp. developed the rocketsonde for ARDC in association with Aerial Reconnaissance Laboratory.

good posibilities for some applications," Dr. Heinemann said.

Regarding engines for VTOL aircraft, Dr. Heinemann noted that minimum weight per pound of thrust occurs in a 3,000 to 5,000 lb. thrust category.

"Increasing weight at higher thrusts is due to the action of the square-cube law, which states that thrust should vary as the square of the diameter and weight as the cube of diameter," he explained.

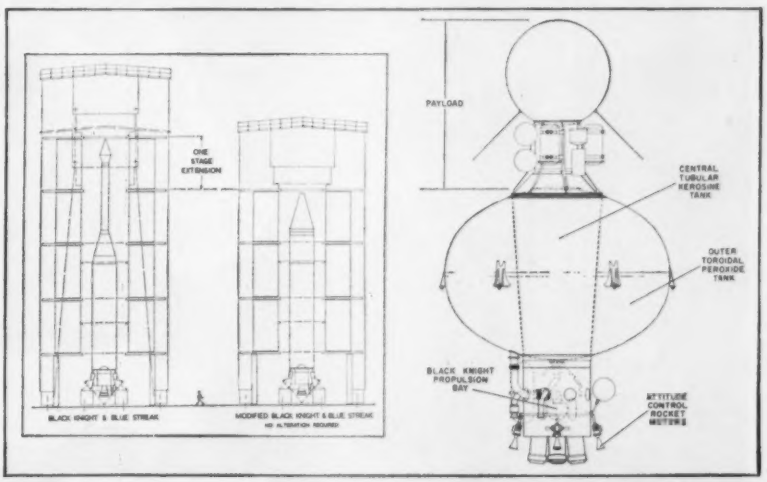
At very low thrust, this law is modified by certain fixed weight accessories and by manufacturing limitations. Use of multiple small engines is an attractive safety feature permitting engine-out operation. Propulsion cost is not necessarily increased by use of multiple small engines since engines in the 5,000 lb. to 15,000 lb. category tend to cost approximately the same per pound of thrust.

An aspect of power selection for VTOL aircraft is that a gas turbine accounts for only about 10% of gross weight in optimum configurations. Other propulsion equipment accounts for over 20% while about 35% is made up of structure and equipment. Because the gas turbine is such a small part of gross weight for VTOL aircraft, payload cannot be much improved by improvements in the weight-to-thrust ratio of the engine. From this type of data, Dr. Heinemann concludes that as far as engines are concerned, VTOL aircraft might just as well be built now, rather than build them five to 10 years in the future.

"This is not true necessarily for other types of VTOL aircraft, such as jet lift fighters where engine and fuel weight make up a larger proportion of gross weight," he continued.

Weapon characteristics have always influenced design of the carrying aircraft. With rapid increase in the effective range of missiles, Dr. Heinemann predicts that a reduction in performance of the carrying aircraft will be acceptable.

In consideration of a long lead time to develop and produce new types of aircraft, Dr. Heinemann suggests greater use of improvements to existing weapon systems. Modernization of equipment and weapons should substantially prolong effectiveness of aircraft. Multimission capability can be supplied by use of alternate types of equipment with a single airframe. He also noted the desirability of supplying a single basic airframe type to more than one military service. Both of these approaches permit greater production quantities, lower unit cost and therefore more units for a fixed expenditure of dollars, he said.



British Propose Compact Black Knight/Blue Streak

British Blue Streak booster topped with Black Knight satellite vehicle (left) will require one-stage extension to Blue Streak missile service tower (AW Sept. 14, p. 108). Use of a more compact Black Knight engine (right) on Blue Streak booster (center) would eliminate need to alter the service tower.

creating controls

Everywhere Hughes systems and missiles *are employed, Hughes Field Engineers insure maximum utilization and field performance.*

Developing new semiconductor materials, *physicists at the Semiconductor Division of Hughes Products utilize highly advanced techniques.*

for the space age

Operating with accuracy at speeds far beyond man's ability to reason and act, the control systems produced by Hughes-El Segundo are blazing new trails in the state of the art.

Recognized as the leader in airborne control systems, Hughes is responsible for the controls in our most advanced weapons systems. And, today, Hughes engineers and scientists are expediting work on even more advanced systems which will help carry man on his first probes into space.

This work demands engineers of special ability, who are capable of translating theory into hardware of fantastic accuracy and dependability. A large share of engineering time at Hughes El Segundo is spent in the continuing development of these systems... and in the development of equipment and methods to support the program.

The systems philosophy is characteristic of all Hughes activities...covering the spectrum of electronic progress: space vehicles, plastics, nuclear electronics, infrared devices, advanced data processing and display systems, microwaves, global communications, ballistics missiles and many others. These activities provide stimulating outlets for creative engineering talents.

Hughes Products, the commercial activity of Hughes, has assignments for imaginative engineers in several areas of research in semiconductor materials and electron tubes.

The great variety of advanced projects...the stability stemming from a position of leadership ...and Hughes engineering-orientation creates an ideal environment for the engineer or scientist interested in advancing his professional status.

Newly instituted programs at Hughes have created immediate openings for engineers experienced in the following areas:

Logical Design	Communications
Digital Computers	Thin Films
Infrared	Microwave Tubes
Plasma Physics	Circuit Design & Evaluation
Field Engineering	Systems Design & Analysis
Quartz Crystal Filters	Semiconductor Circuit Des.

Write in confidence to Mr. Wally Peterson
Hughes General Offices, Bldg. 6-A10, Culver City, Calif.

Creating a new world with ELECTRONICS

HUGHES

HUGHES AIRCRAFT COMPANY
Culver City, El Segundo, Fullerton, Newport Beach, Malibu and Los Angeles, California
Tucson, Arizona

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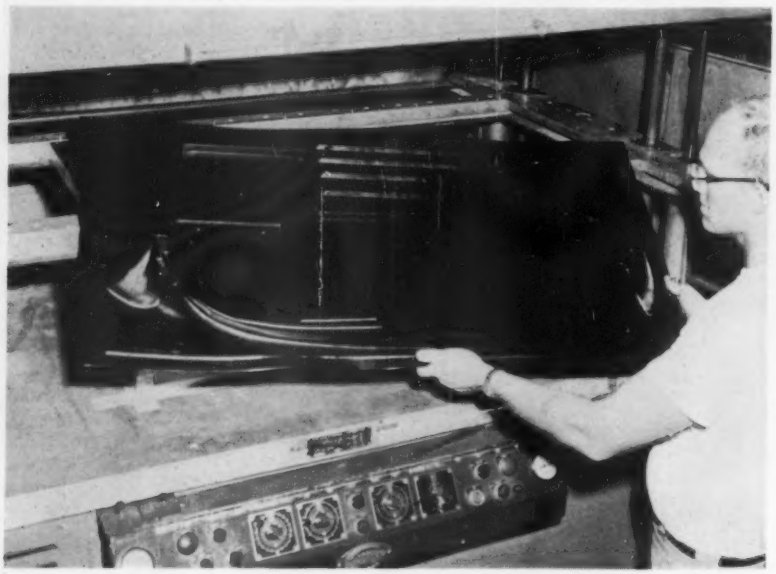
Use of Plastics Increasing in Lightplanes

ROYALITE SHEET, for Skylane instrument panel, is positioned for vacuum-forming.

COMPRESSED AIR is blown for one minute over panel to cool it, after forming process. **PROCESS** entailed holding panel in form for 45 sec. at 900F. Part is then trimmed.



By Erwin J. Bulban

Dallas, Tex.—Trend toward an increasing use of plastics on production business aircraft points to a significant market future for the industrial plastics industry in this area.

How large this future will be depends on the rate that the industrial plastics plants make suitable materials available to business aircraft manufacturers and how soon the latters' engineers complete evaluation of their characteristics, aircraft industry experts indicate.

Right now, according to a top engineer with one of the "Big Three" business aircraft manufacturers, the "stiffness" of plastics is not great enough to make it superior to aluminum. In other words, plastics are too heavy at the present stage of development to compare favorably with the lighter gages of aluminum that can be used, he feels.

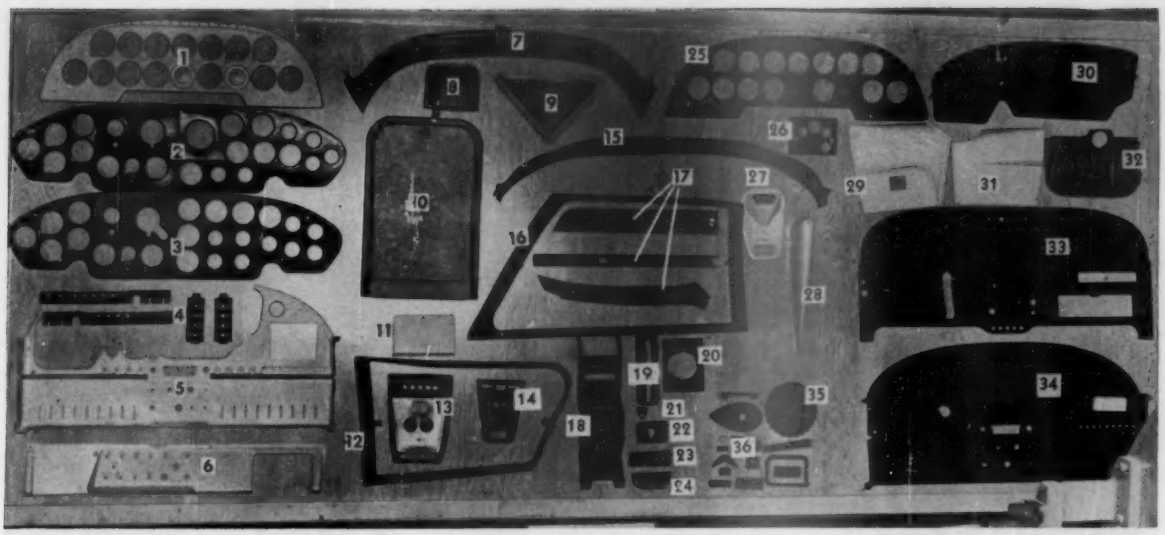
Another factor is cost. For the quality of plastic the aircraft engineer would use in structural members, material would cost something like 90 cents a pound, compared with approximately 50 cents a pound for aluminum.

Structural Purposes

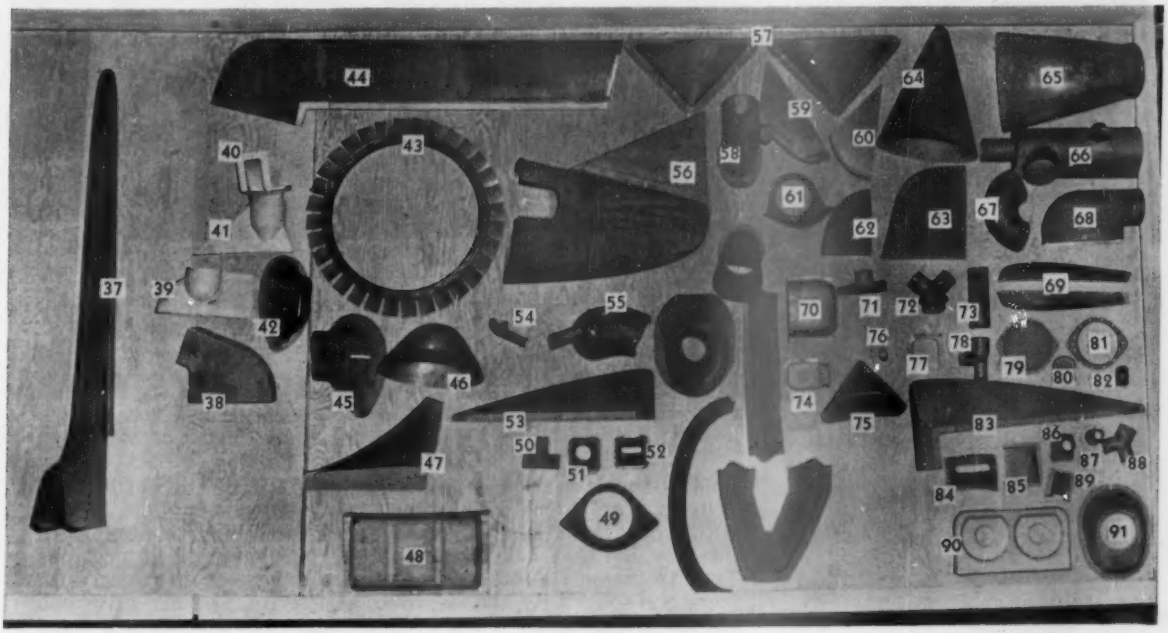
As these deficiencies are overcome and the engineering properties of plastics are better understood, they can be used at an increasing rate for structural purposes, the engineer indicated. With the present state of the art, cost saving can be made by using plastic in tooling rather than using the material in the airplane itself.

Some indication of the strides being made in this field can be garnered from Cessna's experience thus far, as shown in the accompanying photos. Similar work is being done by the other business and utility aircraft manufacturers. With the industry now turning out some 6,500 airplanes annually, even the current use of these materials is impressive—with advent of their use in structural members, the market increase would be on an order of magnitude.

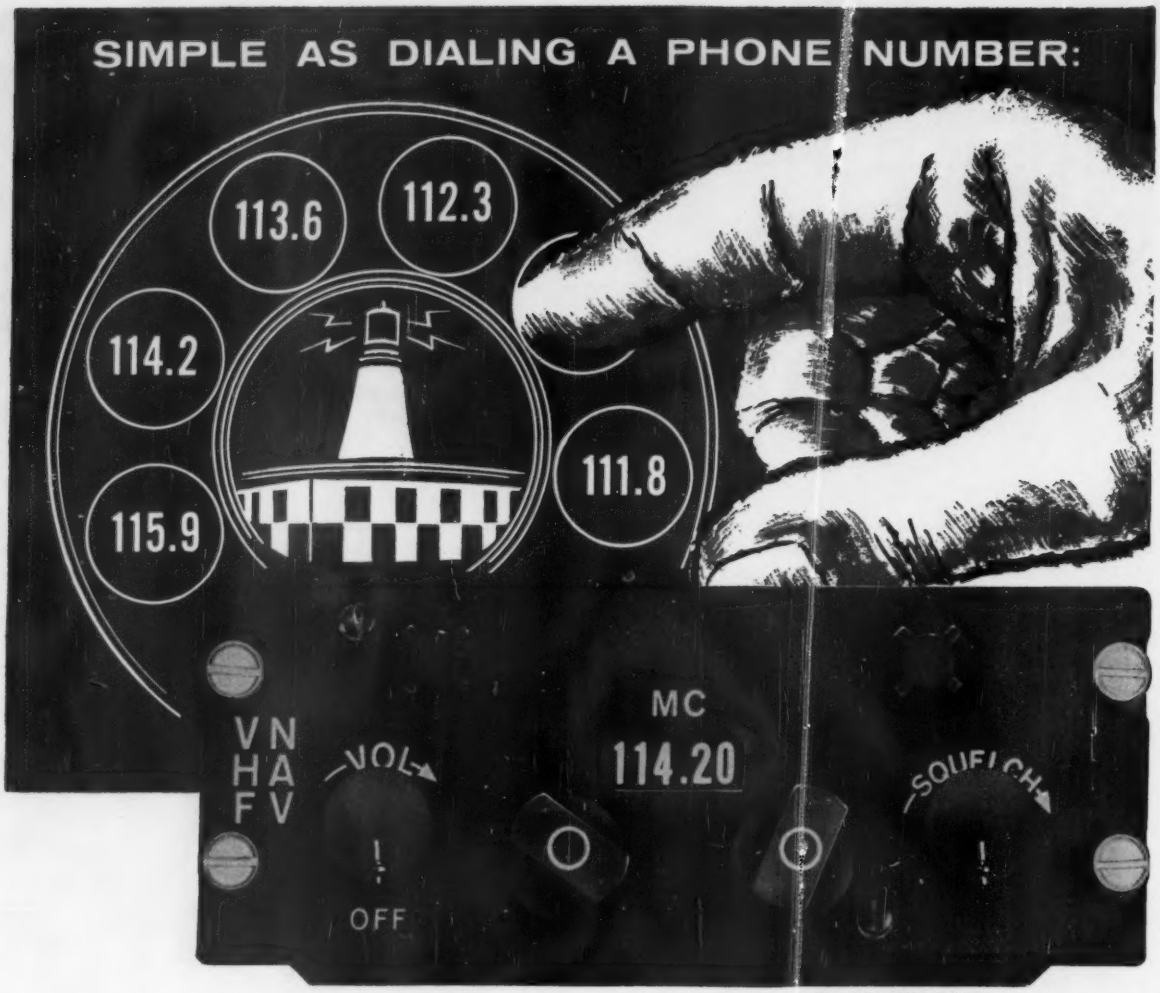
How much so is difficult to predict. According to J. H. Gerteis, chief engineer, Cessna's Commercial Division, the company's engineers feel that they certainly have not reached any limit regarding the use of plastics in aircraft and they have a continuing research program on fabricating additional components. This research extends to theoretical airplane designs which have all, or major, assemblies fabricated from



PARTS DISPLAYED here include: (1) helicopter instrument panel (2) 310 instrument panel (3) 310 instrument panel (4) 180 circuit breaker covers (5) 182 instrument panel (6) 172 panel cover (7) 310 window trim (8) 310 cabin air inlet (9) 310 arm rest (10) 310 seat back (11) 172 glove box door (12) 310 rear window trim (13) 310 console covers (14) 310 console covers (15) instrument panel glare shield (16) 310 door window trim (17) 310 trimstrips (18) 310 pedestal cover (19) 310 trim tab cover (20) 182 bungee cover (21) 310 seat light covers (22) 310 seat light covers (23) 310 switch cover (24) 310 door pull cover (25) helicopter panel (26) 310 radio dust cover (27) 172 map light cover (28) 172 rudder fairing (29) 172 side panel (30) 182 shock panel cover (31) 182 side panel (32) 310 fuel selector valve cover (33) 175 instrument and shock panel cover (34) 182 instrument and shock panel cover (35) trim tab wheel (36) phenolic filler blocks. Cessna uses plastics to permit easier forming of difficult contours than would aluminum.



OTHER plastic uses involve: (1) 150 dorsal fin (2) 182 carburetor air inlet (3) 172 rotating beacon tip (4) 310 carburetor airbox adapter (5) 182 rotating beacon tip (6) 182 strut fairing (7) helicopter fan (8) 310 fin-leading edge (9) 182 strut fairing (10) 310 wing tank nose cap (11) 310 wing fillet (12) 310 rudder pedal cover (13) helicopter landing light bracket (14) 310 tee adapter (15) 310 bulkhead adapter (16) 310 bulkhead adapter (17) 310 elevator tip (18) 310 carburetor air blast tube (19) helicopter supercharger cover (20) 310 tail cone (21) 310 arm rest (22) 310 bulkhead adapter (23) 182 stabilizer tip (24) 182 fin tip (25) helicopter light bracket (26) 310 stabilizer tip (27) 310 fin tip (28) 310 wing tank rear cone (29) bulkhead adapter (30) 310 plenum chamber (31) 310 elbow adapter (32) 182 carburetor air adapter (33) helicopter stabilizer tips (34) 310 cabin air inlet (35) 310 plenum end (36) 310 Y adapter (37) 310 adapter (38) Wemac valve adapter (39) helicopter antennae bracket (40) 310 pitot tube bracket (41) 310 Wemac valve cover (42) 310 air tee adapter (43) 310 rotating beacon mount (44) 310 air tube cover (45) 310 rotating beacon mount (46) 310 switch cover (47) 310 rudder tip (48) 310 glide slope antenna bracket (49) wire cover (50) 310 bulkhead adapter (51) 310 bulkhead adapter (52) 310 Y adapter (53) 310 chain guard (54) 310 fuel selector valve cover (55) helicopter landing light bracket (56) window trim (57) 310 wire cover (58) 310 stiffener (59) wing inlet air adapter (60) 310 nose air inlet adapter.

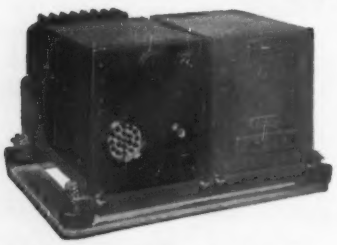


C-81A CONTROL UNIT

ARC'S NEW CRYSTAL CONTROLLED

TYPE 15F VHF/VOR/LOC SYSTEM

CERTIFIED TO FAA TSO'S C-36, C-38, AND C-40 CATEGORY A



To retrofit your earlier model Type 15 system, simply replace the tunable receiver with the R-34A and install the new frequency selector.

This is the latest development in the ARC line of VOR/LOC systems. The Type 15F system was designed using the R-34A, ARC's new crystal-controlled receiver. Combining this unit with the new B-13A-1 Converter and the proven units of previous Type 15 systems, ARC offers you greater ease of operation with increased sensitivity and improved selectivity. The 15F gives you full coverage of all VOR/LOC navigational frequencies from 108.0 through 117.9 mc plus communication frequencies between 118.0 and 126.9 mc. See this new equipment at your ARC dealer now.

Dependable Airborne Electronic Equipment Since 1928

ARC Aircraft Radio Corporation BOONTON, N. J.

OMNI LOC RECEIVERS · COURSE DIRECTORS · AUTOMATIC DIRECTION FINDERS · 360 CHANNEL VHF TRANSMITTER-RECEIVERS · GLIDE SLOPE AND MARKER BEACON RECEIVERS · 10-CHANNEL ISOLATION AMPLIFIERS · INTERPHONE AMPLIFIERS · CABIN AUDIO AMPLIFIERS · OMNIRANGE SIGNAL GENERATORS AND STANDARD COURSE CHECKERS · 900-2100 MC SIGNAL GENERATORS · UHF AND VHF RECEIVERS AND TRANSMITTERS (5 TO 360 CHANNELS).

plastic, he notes, including cost analyses.

Major effort now is studying new areas where they can be used, particularly lightweight high-strength applications. Needed are plastics that can be easily tooled and formed.

This is evidenced in the direction the company has gone thus far on a production basis. Currently some 96 separate parts for Cessna business aircraft are made of Fiberglas. Sheets are used, pre-impregnated with polyester-resin, reinforced with dry Fiberglas sheets. Five layers of sheets are used—three dry reinforcement sheets, alternated with two impregnated sheets.

Some components, notably instrument panels, are made from Royalite—a copolymer modified with synthetic rubber, combining the latter's elasticity with the rigidity of plastic.

All told, Cessna each month uses some 2,000 yd. of pre-impregnated Fiberglas and some 60,000 yd. of Royalite. The company began using these materials on a production basis in 1952, expanding their applications constantly with experience. Practically all plastic parts are fabricated in the company's plants—exceptions are the streamlined wheel fairings, which are purchased.

Thus far, the company has experienced no cost or weight saving in its use of plastics, it reports—the materials being used primarily because they are easier to form in difficult contours and because shapes can be made that would be practically impossible to handle with aluminum.

These so-called secondary parts include tail cones, wingtips, rudder fairings, stabilizer tips, dorsal fins and control knobs. A recent new application is use of foam-type material, as on the company's latest business airplane, the Model 210. This aircraft incorporates plastic "foaming" in the elevator trailing edges and the elevator trim tab, eliminating need for ribs and reinforcing of these parts.

According to Gerteis, experience to date has been "only a good beginning" and although the material offers much, it needs to be developed further by aircraft companies.

PRIVATE LINES

Soviet parachute jumper successfully ejected from a jet airplane flying at 678 mph., surpassing previous Russian test speed of 643 mph., made eight years ago.

$40,000 aerial mineral survey contract covering Northern Ferry and Okanagan Counties has been awarded Hunting Geophysical Services of New York by Washington State Conservation Dept. Field work is to be completed this month, reports are to be made next February.

Heli-Coil® Stainless Steel Screw-Lock Insert is easily wound into tapped hole in lightweight aluminum housing. Spring tension of the locking coil retains screw securely, meets military specifications for locking torque and vibration.

How Carrier Corporation

Saves 40% in weight • 30% in assembly time

...with *HELI-COIL*® SCREW-LOCK INSERTS*

Use of aluminum lightens Carrier refrigeration system in Douglas DC-8 Jetliner

To reduce weight in the refrigeration system designed for air conditioning the giant Douglas DC-8 Jetliner, Carrier engineers used aluminum alloy compressor castings. To obtain maximum performance and reliability of threaded connections exposed to heat and vibration encountered at 600 mph, they selected the *Heli-Coil* stainless steel wire thread, *internal locking* Screw-LOCK Insert.

The results: design simplified, boss areas minimized, weight reduced as much as 40%, lock nuts and lock wiring eliminated. Now one man assembles the entire unit in 30% less time than before ... and danger of thread failure and screw loosening has ended!

Manufacturers in every field are relying on one-piece, stainless steel *Heli-Coil* Screw-LOCK Inserts to meet torque and vibration specs... protect threads against wear, stripping, galling and corrosion... save costs, space and weight. *Patented

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***HELI-COIL* CORPORATION, 210 Shelter Rock Lane, Danbury, Connecticut**
I'd like more information on *Heli-Coil* Screw-LOCK Inserts

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FIRM_____
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CITY_____ZONE____STATE_____ 1959

IN CANADA: W. R. WATKINS CO., Ltd., 41 Kipling Ave., S., Toronto 18, Ont.

GRUMMAN GULFSTREAM (left) and Fairchild F-27 are lined up on ramp at AiResearch Aviation Service Division in Los Angeles.

Gulfstream Interior Keyed to Acoustics

By Russell Hawkes

Los Angeles—AiResearch Aviation Service Division here keys design of $50,000 nine-place executive interiors for the Grumman Gulfstream executive transport to thorough acoustical analysis, careful consideration of the owner's aesthetic tastes, and quick delivery. The division has contracts for three installations and six more good prospects.

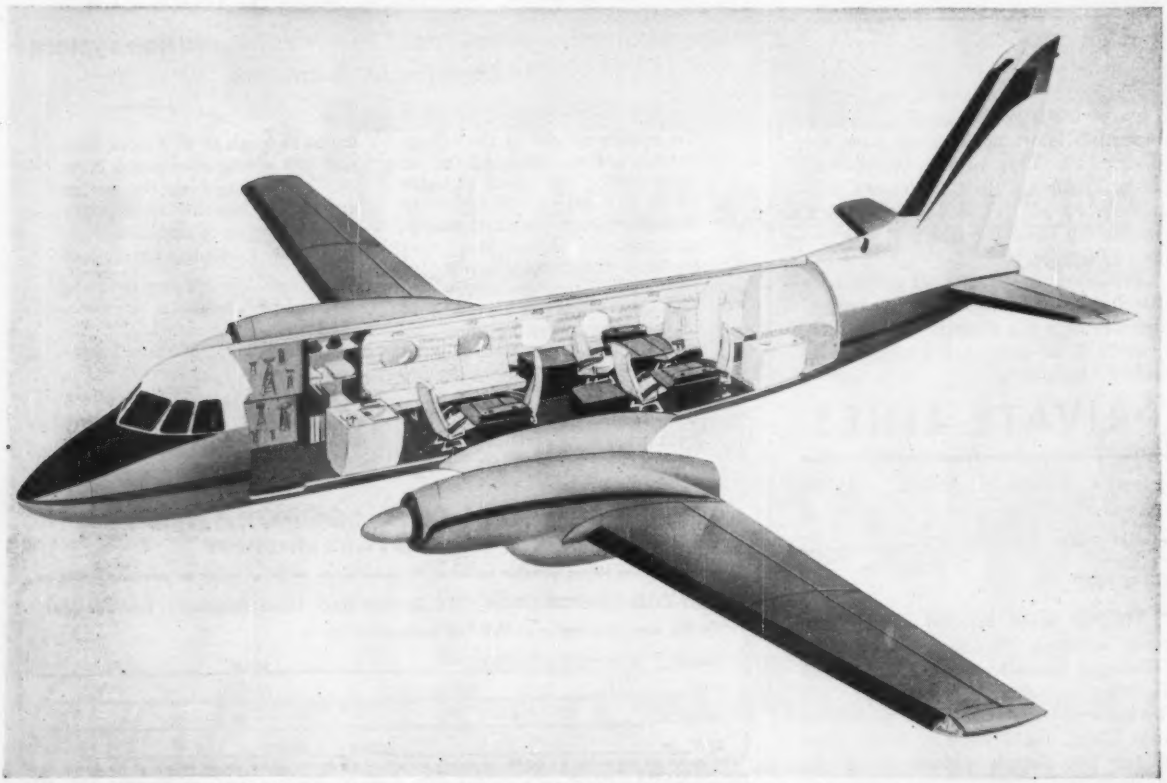
AiResearch, a division of the Garrett Corp., is one of the few big modification centers installing Gulfstream interiors and avionics which does not hold a Grumman distributorship for the airplane. Grumman delivers the airplanes to modification centers bare, even removing flight instruments, radio equipment used during delivery flight.

AiResearch Sales Engineer H. F. Richardson says the practice results in a curious customer psychology. In a sense, he is buying a pig in a poke since the airplane is not finished until the purchase is completed. A sales approach must be planned to relieve his sense of insecurity about his half-million dollar investment.

Speedy completion of the job is a vital goal for Aviation Service Division. An executive transport is an expensive tool and buyers are sensitive about down-time piled up during the modification process. Company officials are now quoting an eight-week down-time for its modification work.

AiResearch is about to revise this period downward to six weeks and ultimately it hopes to bring it down to four weeks through wider use of prefabricated assemblies. The most expensive part of the Gulfstream completion program is installation of avionics which average about $125,000, but the most time-consuming part is design and installation of interiors.

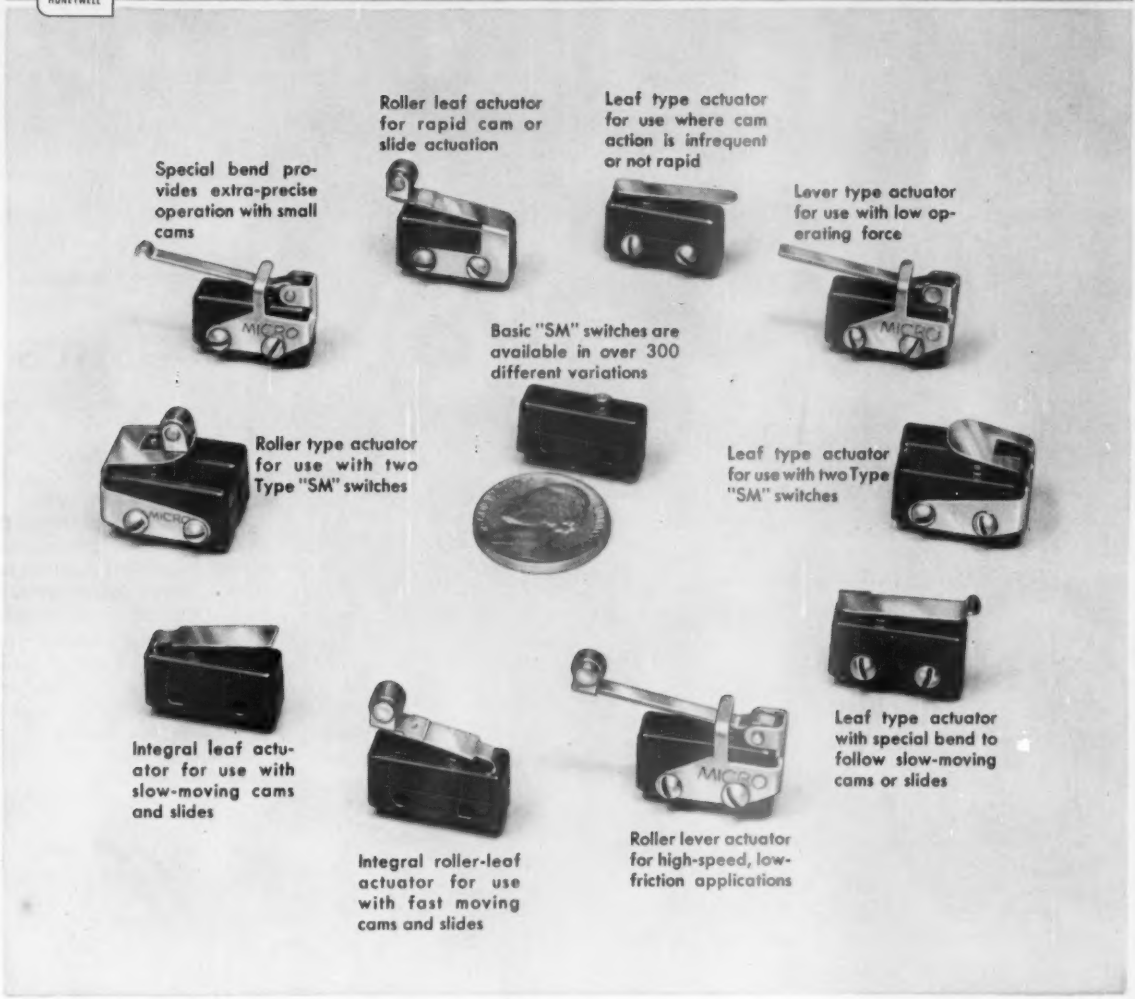
Instrument panel and avionics jobs



EXECUTIVE INTERIOR for Gulfstream designed by AiResearch includes galley—berthable divan, folding tables, storage cabinets, lavatory.

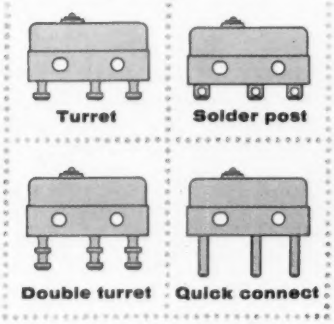
H HONEYWELL

MICRO SWITCH Precision Switches


Special bend provides extra-precise operation with small cams
Roller leaf actuator for rapid cam or slide actuation
Leaf type actuator for use where cam action is infrequent or not rapid
Lever type actuator for use with low operating force
Basic "SM" switches are available in over 300 different variations
Roller type actuator for use with two Type "SM" switches
Leaf type actuator for use with two Type "SM" switches
Integral leaf actuator for use with slow-moving cams and slides
Integral roller-leaf actuator for use with fast moving cams and slides
Roller lever actuator for high-speed, low-friction applications
Leaf type actuator with special bend to follow slow-moving cams or slides

Ten different ways to actuate this small, dependable switch

ACTUAL SIZE



"SM" switches are available with these four kinds of terminals

Here are ten "SM" subminiature switches equipped with ten different integral and auxiliary actuators that contribute to the great versatility of these dependable, small switches. For ten years MICRO SWITCH subminiature switches have been the choice of designers who require switches of high electrical capacity which can be mounted in small space.

For complete information on the MICRO SWITCH lines of subminiature and sub-subminiature switches, we invite you to contact your nearby MICRO SWITCH branch office, or send for Catalog 63.

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New from Clary!

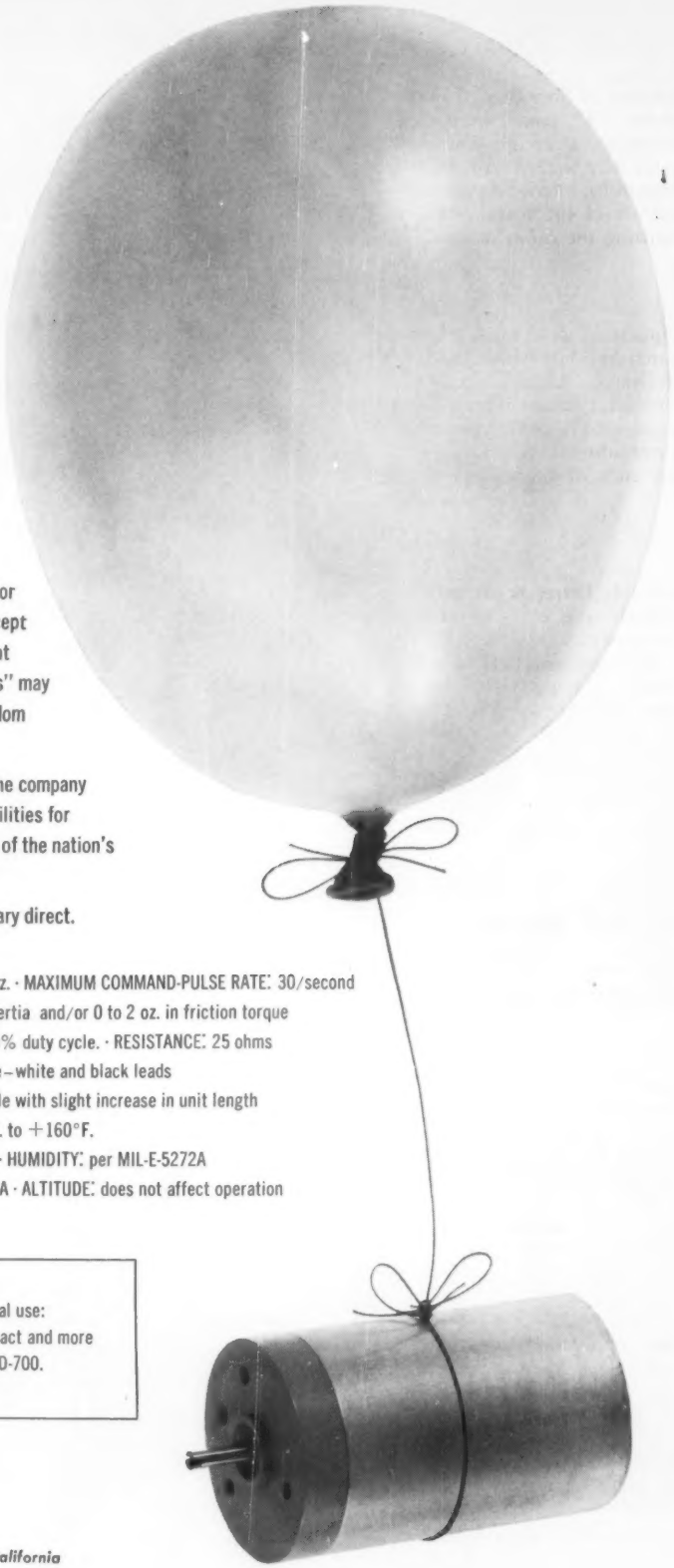
AN 8-OZ. STEPPER MOTOR!

New unit is small... surprisingly low in cost... extremely accurate!

Now from Clary comes a small, lightweight incremental motor with extremely high repetitive accuracy. The unit will accept consecutive command pulses from either of two independent sources in any order, and resulting successive shaft "steps" may be continuously clockwise or counter-clockwise, or any random combination of the two directions.

This high-quality motor is a standard shelf item at Clary – the company whose long experience, outstanding staff, and complete facilities for extreme environmental conditions testing have made it one of the nation's leading manufacturers of automatic controls.

For detailed information on this exceptional motor, write Clary direct.



SPECIFICATIONS: Clary CD-700 Incremental Motor · WEIGHT: 8 oz. · MAXIMUM COMMAND-PULSE RATE: 30/second
LOAD: will drive a load possessing 0 to 25 gm cm² moment of inertia and/or 0 to 2 oz. in friction torque
INPUT VOLTAGE: 28 v dc · POWER: 15 watts average power at 50% duty cycle. · RESISTANCE: 25 ohms
DIRECTION: clockwise–red and black leads...counter-clockwise–white and black leads
ANGULAR TRAVEL: 36° per pulse, standard. Other values available with slight increase in unit length
DESIGN LIFE: 10^4 cycles each direction · TEMPERATURE: −65°F. to +160°F.
VIBRATION: 5 cps to 600 cps at 10 g or .020" double amplitude · HUMIDITY: per MIL-E-5272A
SALT SPRAY: per MIL-E-5272A · SAND AND DUST: per MIL-E-5272A · ALTITUDE: does not affect operation
MOUNTING: standard AN servo mounting available

Also available for commercial use:
an even smaller, more compact and more economical version of the CD-700.

Clary

Clary Dynamics
Dept. AS-119 San Gabriel, California
Manufacturer of business machines, electronic data-handling equipment, aircraft and missile components.

require a minimum of engineering since corporation chief pilots usually have well-defined ideas about what they want in these areas. Most seem to favor some variation of Society of Automotive Engineers "T" panel arrangement. Interiors are a far different matter since tastes vary widely. AiResearch tries to standardize interior installations forward and aft of the main cabin while customizing the cabin itself.

Acoustical Treatment

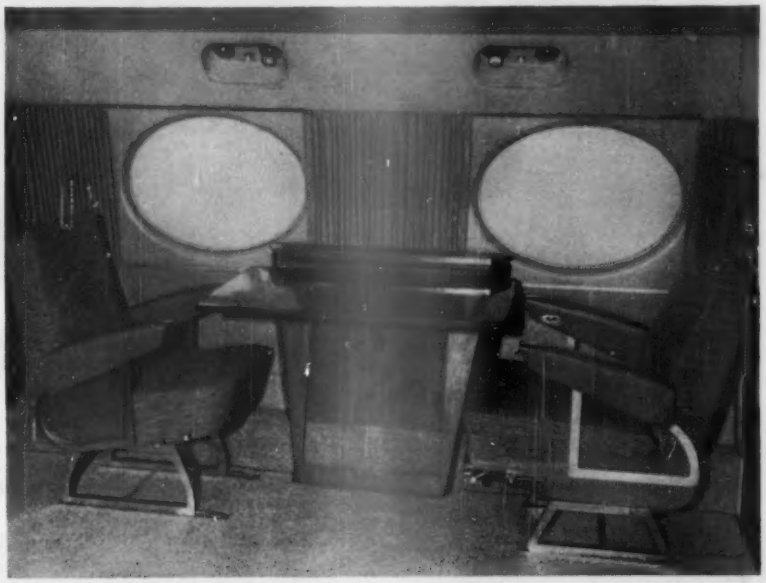
Three acoustical treatments for the Gulfstream were worked out for AiResearch by Matt Miller, acoustics expert of Douglas Aircraft Co., working in a consultant status. The quietest version is intended to permit reasonably normal conversation between people at opposite ends of the cabin. Lightweight, minimum damping installation is intended to permit conversation across the aisle. Studies showing about a 75 db. noise level indicate that it is considerably better than the 95 db. level characteristic of quiet propeller-driven transports.

All three acoustical treatments are assembled from standard parts and the three acoustical comfort levels are obtained by varying the number and distribution of these parts. Interior sound absorption is controlled with conventional acoustical blanketing covered with porous trim materials. Distribution and weight of sound damping and absorbing materials was established mainly by propeller noise levels to be controlled. Acoustical treatment for the cockpit is a separate problem and is now being studied. Areas to be treated are odd-shaped and small and until recently Miller and his colleagues lacked an airplane with which to make detailed studies. The quietest acoustical installation weighs 263 lb. and permits easy conversation including all the people in the cabin. Minimum installation weighs 156 lb. and intermediate installation weighs 212 lb.

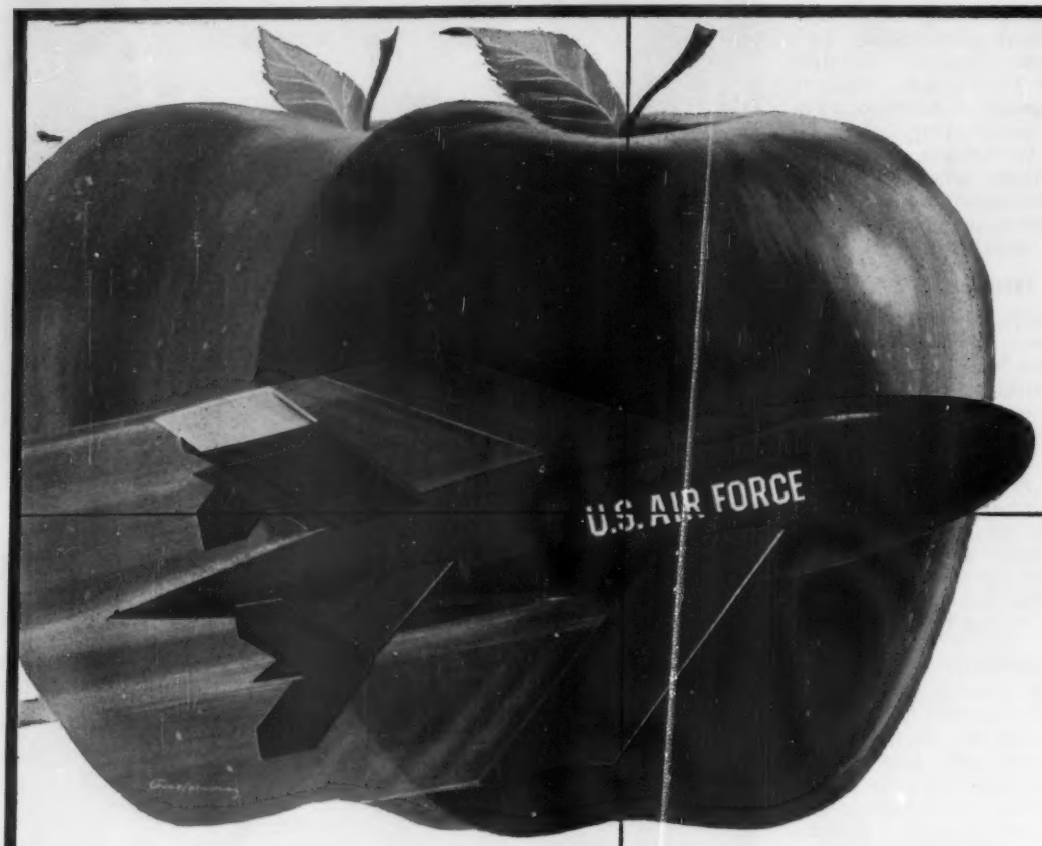
Principal noise source is the propellers. Jet exhaust does not contain enough energy to be a serious problem. Fuselage length is short enough and cruise speed is low enough to rule out boundary layer noise as a major problem. Nuisance noise sources, such as hydraulic, electrical and air conditioning components located beneath and in passenger cabin, are being checked.

In a preliminary report to AiResearch, Miller said that although Gulfstream is a high performance aircraft, most propeller parameters have been well selected from the standpoint of acoustical comfort in the cabin. Tip clearance is a generous 30 in., four blades are used rather than three and the plane of the blades is well removed from passenger and crew. Miller re-

SWIVEL CHAIR in Gulfstream mockup is shown with footrest extended (right, above). Work table is folded against cabin wall. Below, the table is shown in opened position.



FORMICA/WOOD laminate is on honeycomb framework below to be formed into tabletop.



RYAN FIREBEES STAR AGAIN AT SECOND "WM. TELL" MEET

The Air Force has selected Ryan Firebees as the exclusive targets for Project "William Tell II"—the second annual world-wide weapons meet to use free-flying jet targets for the purpose of testing pilots, planes, and missiles.

The Ryan Firebee—America's most widely used jet target and the hit of "William Tell I"—provides the most economical and realistic means of maintaining air defense weapons at combat readiness. Firebees stay "on station" for extended periods—permitting numerous attack sorties. And they can be used over and over again.

Pitted against the Firebees will be the top Air Defense Command squadrons, flying Convair F-102, Lockheed F-104, Northrop F-89 and North American F-100 interceptors. They will fire deadly Falcon and Sidewinder guided missiles and Genie (atomic-type) rockets.

The advanced, new transonic Q-2C Firebee—now in production for the Air Force—has already set world's records by flying faster (mach .95), higher (59,800 feet), and longer (99½ minutes).

Ryan has led the field in the design, development, and production of jet target missiles for more than ten years. The Firebee is another outstanding example of Ryan's skill in blending aerodynamics, propulsion, and electronics knowledge to produce a superior product.

RYAN OFFERS CHALLENGING OPPORTUNITIES TO ENGINEERS

RYAN BUILDS BETTER

AIRCRAFT · MISSILES & COMPONENTS · ELECTRONICS

Ryan Aeronautical Company, San Diego, Calif.

ported that helical tip Mach number of the propeller is the only parameter which could have been improved from the standpoint of noise.

Miller explains that, "Since the Gulfstream is a pressurized aircraft, there is no direct path for the propeller noise to take into the cabin. For an external noise to be heard inside, the external sound must shake the fuselage well enough for it to reradiate the sound into the internal volume of the fuselage.

"Not only does the passenger hear noise passing through the wall closest to the noise source, but that which is reradiated from every other area in the fuselage surface, the floor and the fore and aft bulkheads of the cabin.

"Thus it can be seen that no matter where material is installed in a fuselage wall it will influence interior noise levels. Moreover, if there were very little sound-absorbing material in the cabin, sound would reverberate throughout the interior volume and it would be heard almost as well anywhere in the cabin as at the point closest to the noise source. However, with plenty of absorption, it becomes practical to tailor the local weight of the acoustic treatment to the local exterior sound it has to withstand."

Soundproofing Components

As to the central components of a soundproofing system, Miller cites:

• **Structure.** Plating, longerons and frames provide the stiffness and a large part of the mass opposing passage of sound waves over most of the audible frequency range.

• **Sound-damping tape.** Two-faced, pressure-sensitive material with a sheet of aluminum foil bonded to one face is applied in layers to the skin panel. It damps motion of the skin panels at their resonant frequencies and provides additional mass. Miller recommends uniform application rather than pyramiding of tape on the center of the panels.

• **Between-frame blankets.** These are used to absorb noise radiating off the skin panels and provide additional pressure and damping on the skin panels. They should be designed 10 to 20% larger than the space between the frames to prevent noise passage around the edges.

• **Over-frame blankets.** These absorb some of the noise which is transmitted by the frames, thus escaping the effect of between-frame blankets.

• **Trim.** Trim materials must suit the interior decor but porous or open weave trim cloth is useful acoustically since less noise is reflected off its surface. Hard panels should be isolated to prevent them from vibrating with the frame to which they are attached.

Fail-safe pressure fuselage structure of Gulfstream confers a bonus in soundproofing. Use of more structural members and smaller ones under this structural design concept reduces the unsecured areas of skin panels. This, and the thicker skin used, reduces the amplitude of panel vibrations, making possible a reduction in the amount of acoustical tape and blanketing used.

Main considerations in interior design are styling, function and weight. AiResearch interior designers find that the Gulfstream calls for an entirely different decor than the bigger Convairs and DC-3s which have made up the bulk of the company's past business. A heavy luxurious atmosphere has been the rule in these with leather-covered arm chairs and paneled walls emphasizing the theme. In smaller aircraft such as the Gulfstream, this atmosphere would be overpowering. AiResearch decor for the Gulfstream will tend toward lighter, more airy forms and colors of contemporary design. Aside from aesthetic considerations, trim and furniture designed along these lines weigh less.

AiResearch custom-fabricates tables, desks, consoles and kick panels of paper honeycomb with Formica surfaces. Sideward-facing divans that are convertible to berths are not paneled around the legs. This, combined with the fact that seat belts are tied directly into side wall intercostals, keeps the divans light.

Seat belt fittings at the intercostal are swiveled to accommodate impact loads. Conversion is made by pulling the seat backs out of deep plugs in the divan seat. When in use as a divan, the seat slopes downward from front to rear. In converting it to a berth, the seat bottom is pulled forward and a cam track and rider raise the back edge of it level. The plug-out back makes available about an extra 8 in. of width for sleeping purposes.

Non-berthable version of the divan takes seat loads directly through its own structure, rather than directly into cabin wall structure.

AiResearch designers are recommending installation of Burns Aero Seat Co. Model 10-G-A1 swivel chairs.

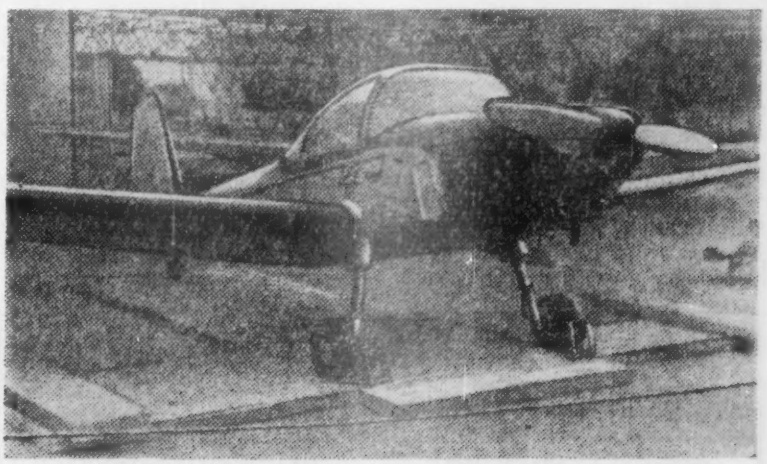
Rugged floor structure of Gulfstream with integral seat tracks in longitudinal floor beams preconditions all AiResearch interior design. All furniture, including galley fixtures, ties to these seat tracks. Honeycomb panels between and around the flush tracks are not intended to bear crash loads.

Fabrics used in AiResearch's interiors cost up to $30 per yard for imported cloth used in curtains and seat backs. Recommended head liner material costs from $11 to $14 per yard.

AiResearch Gulfstream interior will have a total weight in the neighborhood of 1,200 lb. Either storage or cooking galleys will be offered. AiResearch recommends use of an ice chest rather than a refrigerator in the galley because of the long time needed by a refrigerator to pull temperature down.

AiResearch fabricates its own honeycomb panels for interior installations. They are made of paper honeycomb core and two-ply poplar veneer skins which can be covered with a decorative surface of Formica, or padded and covered with fabric or vinyl.

Grumman supplies an air conditioning and ducting system powered by a gas turbine in the fuselage tail section on the ground and by a bleed air bootstrap turbocompressor in flight. Gas turbine for ground air conditioning weighs 202 lb.



Polish PZL-102 Displayed at Moscow

Polish aviation display at Moscow industrial exhibition featured the 65-hp. PZL-102 Kos all-metal lightplane (above); the two-place Boclan-ID Stork; a single-place Jasolka-ZO Swallow and Mucha-100A Fly gliders. Also shown were the MD-12 glider with four auxiliary engines and the PZL-101, patterned after the single-engine Russian three-phase Yak-12.

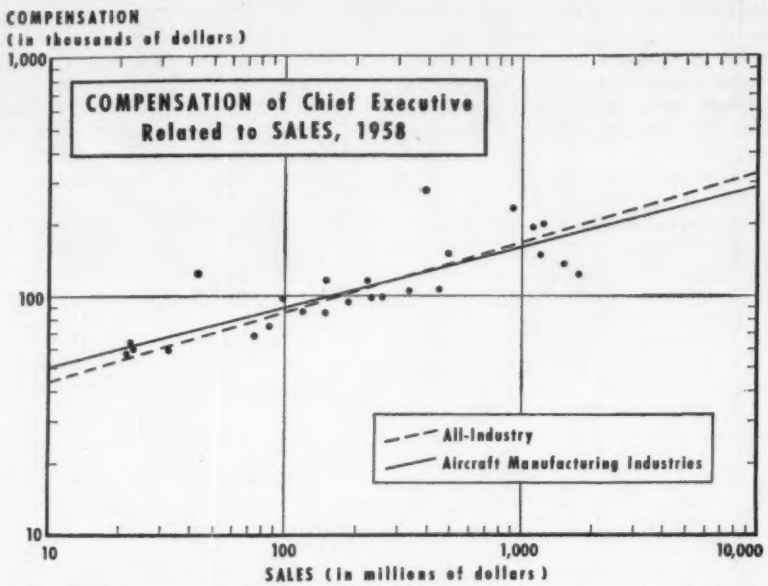
Profit Drop Shaves Some Executive Pay

New York—Aircraft executives' compensation is generally in keeping with the average executive compensation paid in other industries, according to Philip H. Dutter of McKinsey & Co., Inc., management consultants.

A total of 791 companies listed on major stock exchanges was surveyed by McKinsey & Co. Financial results and compensation data were analyzed on the basis of averages for all industry, and for 23 separate industries. Compensation includes salary, incentive bonuses and deferred compensation granted for 1958.

Compensation paid chief executives of 25 major aircraft companies in 1958 increased by an average of 3.6% over 1957 despite an 0.8% decline in sales and a drop of 18.9% in profits for the 25 companies. In comparison, average compensation for chief executives of all 791 companies declined for the first time since the survey was begun in 1955; the drop was 1.8% from 1957.

This decline in executive compensation was most noticeable in industries whose profit results were most severely affected by the recession. For example, the compensation drop was 3.0% in steel, 4.3% in nonferrous metals, 5.3% in automotive parts, and 8.7% in industrial machinery.



EACH DOT represents one of 25 aircraft companies. Its position indicates the relationship between chief executive compensation and 1958 sales of that company. Aircraft manufacturing line represents average relationship between sales volume and chief executive compensation for the industry. This line shows that an aircraft company with sales of $25 million, for example, is likely to pay its chief executive about $64,000. Chart also shows an all-industry sales-compensation line, constructed on basis of data reported by all 791 companies.

Compensation vs. Profits

The main reason for a parallel relationship between executive compensation and profits in most industries is the prevalence of profit-based incentive bonus plans for chief executives, Dutter said. In the aircraft industry, however, this relationship was not parallel this year in spite of the fact that nine of the 25 companies had incentive compensation plans.

Three of the four companies that increased their chief executive compensation, despite a decline in profits, have incentive plans. In one of these companies the reason for the inverse relationship between profits and compensation is that bonus payments reported as part of 1958 compensation are based of 1957 results. In the other two cases, the reason for the inverse relationship was not apparent.

Increased Compensation

The aircraft and petroleum industries were the only two that showed increases in average chief executive compensation in the face of decreased profits. (The petroleum industry showed a 3.8% compensation increase against a profit drop of 19.8%.)

Differences in company size have less effect on chief executives' compensation in the aircraft industry than in most other industries, McKinsey & Co. found. Aircraft companies with sales below $300 million tend to be higher-paying than industry in general. Size differences had a greater effect on compensation in 19 of the 23 industries analyzed.

The 25 aircraft companies surveyed range in size from a sales volume of slightly more than $20 million to a sales volume of about $1.7 billion. The median is $220 million.

Sales Changes

Thirteen of the 25 aircraft companies reported sales increases in 1958, and nine of this group reported profit increases in 1958. Changes in sales volume in the group varied from a rise of 40% to a drop of 35%. Sales for all 791 companies dropped 3.1% from 1957; profits declined 11.7% from 1957.

Of the 25 aircraft companies surveyed, chief executive compensation increased in 14, declined in six, and remained the same in five. Four of the 14 companies that increased chief executive compensation reported lower profits; three of the seven companies that decreased chief executive compensation reported higher profits.

Compensation for the second, third and fourth highest-paid executives in each of the 791 companies was related

Profit-Compensation Relationship

Percentage changes in profits and chief executive compensation for the past three years are shown below. Until 1958, profit trends were reflected in chief executive compensation both in aircraft manufacturing and in industry in general.

	1956		1957		1958	
	Profits	Compensation	Profits	Compensation	Profits	Compensation
Aircraft manufacturing	1.8%	1.3%	10.7%	3.8%	−18.9%	3.6%
All industry	10.0%	5.1%	−3.2%	1.0%	−11.7%	−1.8%

to that of the chief executive, McKinsey & Co. found, and could be expressed as a percentage of the chief executive's compensation. Compensation for these executives in the aircraft industry compares with that in all industry as follows:

	Aircraft	All
• Chief executive:	100%	100%
• Second executive:	72	73
• Third executive:	56	60
• Fourth executive:	47	55

Mergers and Acquisitions

• **Turbo Dynamics Corp.,** Minden, Nev., acquired the Air Products Co. of Los Angeles through issuance of $1,325,000 in long-term notes, assumption of an existing mortgage and common stock in Turbo Dynamics. Air Products, which produces aircraft and missile components, will complement the Turbo Dynamics Huber Tool Works Division which specializes in custom electronics hardware and precision prototype production.

• **Elastic Stop Nut Corp.,** Union, N. J., acquired the Aircraft Bolt Corp. of El Monte, Calif., through exchange of 8,000 shares of Elastic Stop Nut common for all outstanding shares of Aircraft Bolt. Aircraft Bolt makes various types of high strength bolts for aircraft and missile applications.

• **Marshall Industries,** San Marino, Calif., purchased the Electron Products Co., a division of Preco, Inc., for $400,000, partly derived from the recent sale of 100,000 shares of common stock at $2.50 a share. Electron Products manufactures precision miniaturized capacitors and radio interference and noise filters. Marshall Industries, basically a combination of five companies grouped under the generic name of the old G. S. Marshall Co., manufacturers' representatives, is in the sales representation field and in design and manufacture of specialty products.

• **Calumet & Hecla, Inc.,** Chicago, and Flexonics Corp., Maywood, Ill., agreed on terms of acquisition of Flexonics by the former, probably in January. Flexonics makes flexible metal hose and related equipment; Calumet & Hecla fabricates nonferrous metal tube and parts.

• **True-Trace Corp.,** El Monte, Calif., merged with True-Trace Sales Corp. and True-Trace Mfg. Corp. and will use the former name only. The company, which produces hydraulic tracing controls for machine tool builders, accompanied the merger with a decision to withdraw from the aircraft contour machine jobbing field to concentrate on its line of machine tool control systems and activity in building control components for missiles and aircraft.

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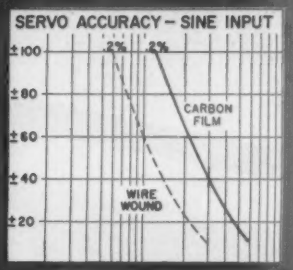
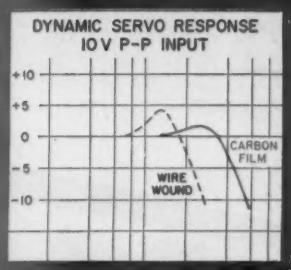
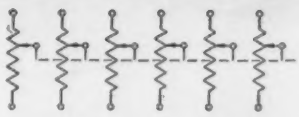
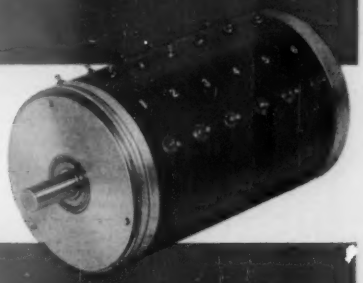






SIX-GANG POT MODEL 205



PROBLEM

Poor resolution and loss of output signal due to wiper bounce of its wire-wound pots limited the speed of servo multipliers in an Analog Computer. This poor dynamic performance, due to the use of wire-wound pots, threatened to obsolete the entire Analog Computer.

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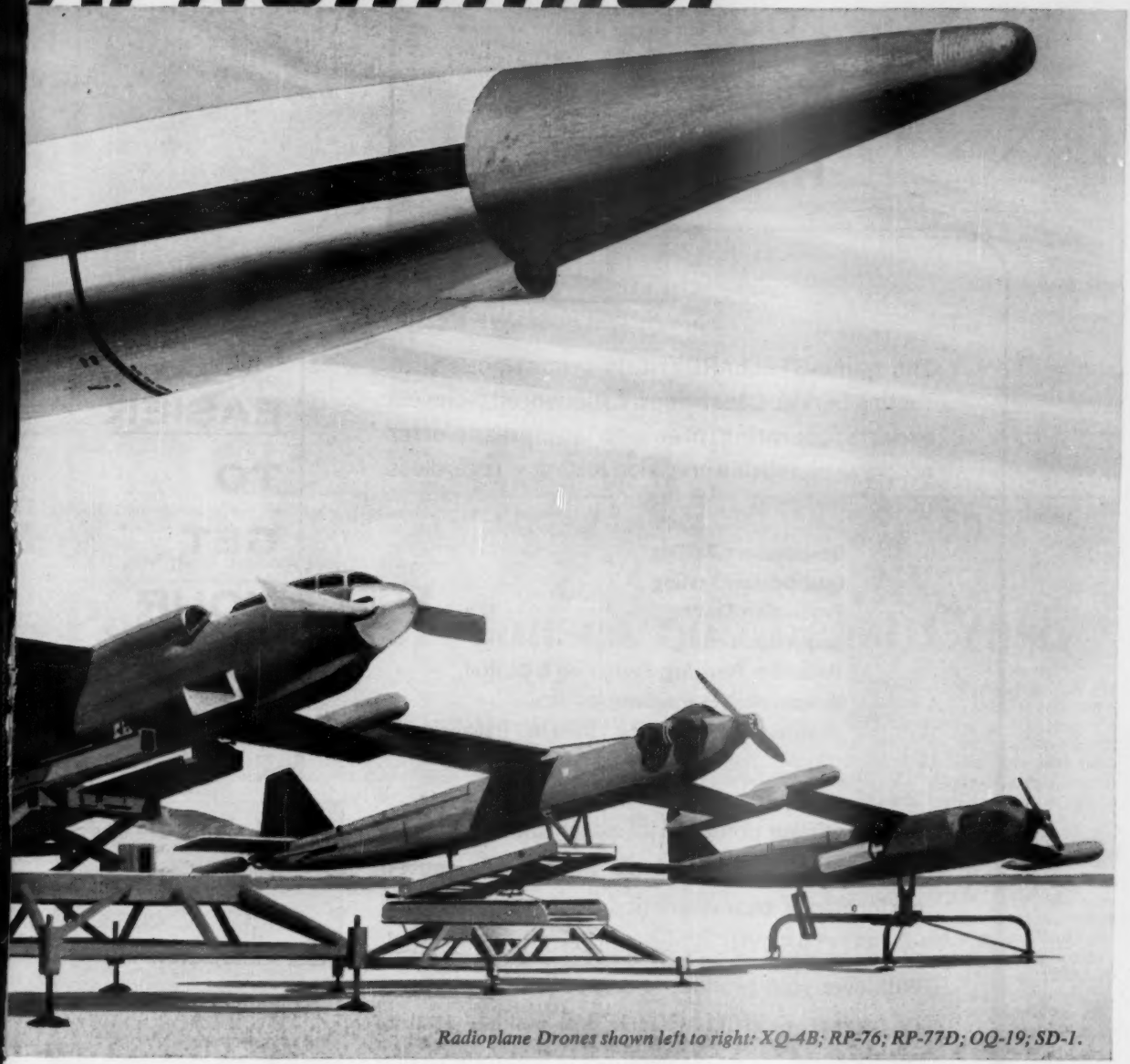
AT NORTHROP



Radioplane Drones shown left to right: XQ-4B; RP-76; RP-77D; OQ-19; SD-1.

NEWS FROM OTHER MEMBERS OF THE NORTHROP FAMILY

NORAIR designs and builds complete weapon systems, missiles, airframes, related products. In production: Snark SM-62 and the first low-cost twin-jet trainer for America's airmen–the T-38 Talon.

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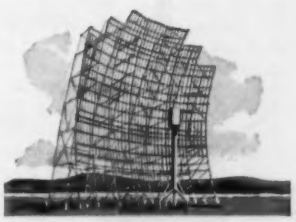

PAGE Communications Engineers, builders of strategic global networks, has been selected by USAF to link England-Spain-Morocco with troposcatter, telephone, teleprinter and data communications.

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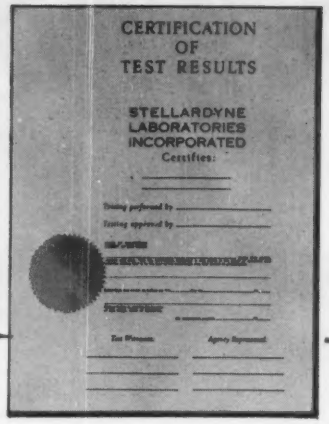
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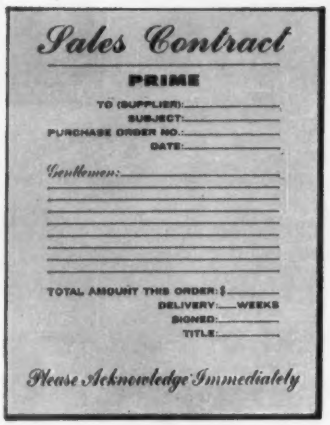
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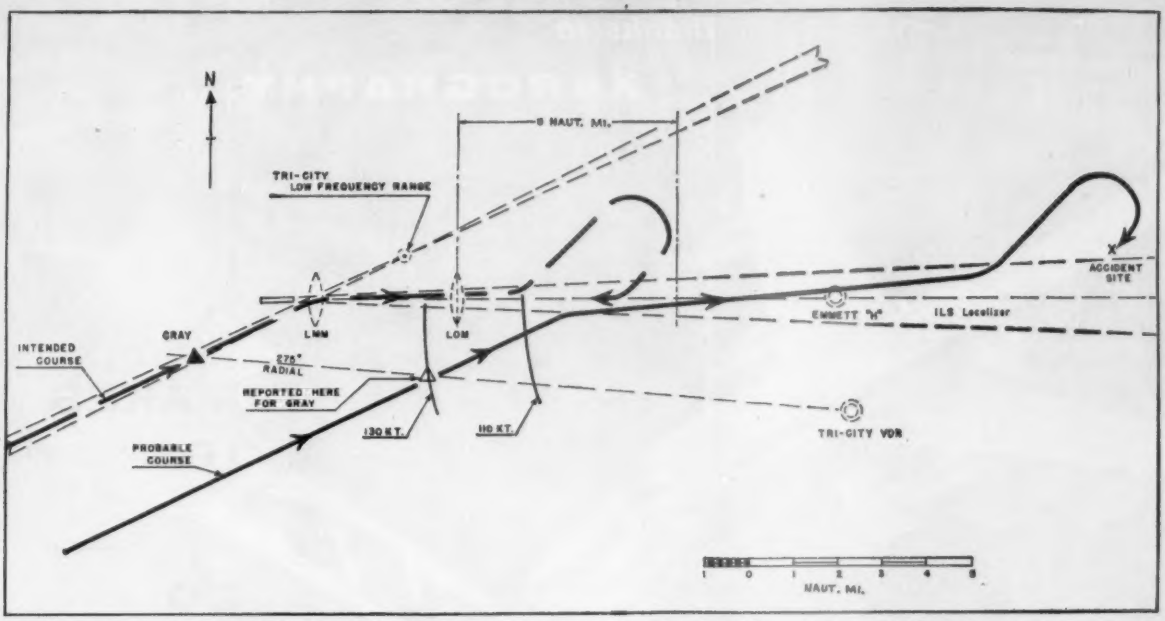

PATHS are shown of the intended and probable courses of a Southeast Airlines DC-3 which crashed near Tri-City, Tenn., in January.

CAB Accident Investigation Report:

Position Error Causes Southeast Crash

On Jan. 8, 1959, about 2032 EST, a DC-3, Southeast Airlines Flight 308, struck a mountainside during an ILS approach to the Tri-City Airport, Tenn. The aircraft was demolished by the impact and subsequent fire. All occupants—seven passengers and three crew members—received fatal injuries.

The evidence indicates Flight 308 departed Nashville, Tenn., with an inoperative radio compass. Although the flight was cleared by way of low frequency airway Green 5, it does not appear that the facilities defining this airway were used. Upon arriving in the Tri-Cities area the aircraft was east of its intended track, and erroneously identified the reporting point from which an ILS approach procedure was to be initiated.

During the instrument approach, which was conducted in snow showers, the flight missed the outer marker. The approach was continued under instrument conditions without utilizing the VOR facility which would have been of assistance in confirming the flight's position. Without having clearly established his position, the pilot flew 15 mi. beyond the outer marker and descended to an altitude too low to clear high terrain in this area.

INVESTIGATION

Southeast Airlines is an intrastate carrier not holding a certificate of public convenience and necessity issued by the Board. Flight 308 is a regular trip which originates in Memphis, Tenn. Scheduled stops are made at Nashville and Knoxville and the flight terminates at Tri-City. The crew for the segment of the trip of Jan. 8, 1959, from Memphis to Nashville, consisted of Capt. Thomas A. Bond, First Officer Robert M. Irwin, and Stewardess Wanda C. Nalley. Capt. Robert L. Gollmier, who had dead headed on this segment, was scheduled to complete the trip to Tri-City with Mr. Irwin and Miss Nalley while Capt. Bond returned to Memphis.

At Memphis, the crew made normal preparations for the flight. The weather was checked and the necessary flight papers were filed, including an instrument flight rules flight plan. After receiving IFR clearance to Nashville the flight departed Memphis at 1630[1] with Capt. Bond in command and proceeded uneventfully until reaching the Nashville area. Approaching Nashville, Flight 308 was given radar vectoring to the ILS final approach course by Nashville approach control. It then landed at 1807, 19 min. late.

Capt. Bond stated in his testimony at the public hearing that during the approach to Nashville, First Officer Irwin was unable to pick up the compass locator at the outer marker on the ADF (Automatic Direction Finding Receiver). The captain and first officer attempted several times to tune the radio but were unable to receive either an aural signal or a visual indication from the ADF pointer. Capt. Bond stated that upon landing he informed Capt. Gollmier of the malfunction but did not make an entry in the log concerning it.

[1]All times are Eastern Standard unless otherwise specified, and are based on the 24-hr. clock.

Capt. Gollmier took command of the flight at Nashville and made normal preparations for continuation of the trip. A check was made of the weather reports, an instrument flight rules flight plan filed, and ARTC (Air Route Traffic Control) clearance received.

Flight to Knoxville

The stop at Nashville took 18 min., after which the flight proceeded uneventfully to Knoxville. There, during the one-engine-operating stop, the crew was given the flight papers for the remaining segment including the latest Tri-City weather observation, a special report at 1859. It was 300 ft. scattered clouds, measured 600 ft. overcast; 3 mi. visibility; light snow and fog; temperature 33 deg.; dewpoint 32 deg.; wind northwest at 8 kt.; altimeter 29.99.

Cumulative en route delays resulted in the flight departing Knoxville at 1946, 27 min. late. It was given ARTC clearance to the Gray intersection via Green Airway 5 to maintain 5,000 ft. and to contact Tri-City approach control when over the Bulls Gap marker beacon. The estimated time en route was 34 min. at a true airspeed of 145 kt. At 1953 the flight advised the company at Knoxville it was estimating Piedmont fan marker at 1956. A few minutes later it reported over Piedmont at 1958, estimating Tri-City at 2023.

At 2010, in accordance with the clearance, Flight 308 reported over Bulls Gap. Tri-City approach control acknowledged the report and further cleared the flight to make an approach to the airport on Runway 27. The latest weather information was also

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transmitted to the flight: ". . . wind is north, variable both sides at 10 kt., gust to 15; altimeter 30.03; Tri-City weather, measured ceiling 900 broken, 1700 overcast, visibility 3; snow; fog."

Following the acknowledgment of the approach clearance and weather information, the flight switched to company frequency at Tri-City giving an estimated time of arrival at 2026, reporting the aircraft as being O.K. for turn-around, and asking if it still needed sumps and screens checked.[2] The chief dispatcher answered in the affirmative and logged the time of this contact as 2012. The dispatcher was able to identify the transmission as being made by Capt. Gollmier. Twelve minutes later, at 2024, Southeast Flight 308 reported to approach control stating it was over Gray intersection[3] leaving 5,000 ft. making an outer marker approach. The controller advised flight 308 to report leaving the outer marker inbound.

Position Report

At 2032, because there was other traffic in the area, the controller called Flight 308 to ask its position. The captain, who occupied the right seat, at this time asked if the glide slope was operating. The controller advised that it was asked if Flight 308 was inbound to the outer marker. The captain then stated that his ADF was acting up; that he did not pick up the outer marker either aurally or visually and that they were making a procedure turn. The controller acknowledged and asked the flight's altitude. No further word was received from the flight and it must be presumed that the aircraft crashed immediately after its final transmission.

A Piedmont Airlines DC-3 had arrived at the Bristol intersection[4] at 2028 and was holding, awaiting clearance to approach to the airport. The Piedmont pilot, a witness at the public hearing, testified that he was VFR at 5,000 ft., in the holding pattern; however, he could see a cloud layer east of the airport in the ILS approach area which extended from about 3,000 ft. to 7,500 ft. Clear of the clouds, the visibility was more than 15 mi.

He said he could see "lights from several cities to the west and north and could see the Tri-City Airport." The Piedmont captain testified that he heard the conversations between Flight 308 and the approach controller at 2024 and 2032 and was concerned after the latter, when he could not see the Southeast aircraft in the Bluff City area. He said he made special note of the time, 2032, because he knew Flight 308 should not still be eastbound eight minutes after passing Gray intersection. However, he did not see any other aircraft in the area. Several minutes later he canceled his IFR flight plan and proceeded VFR to the airport via the radio range, landing at 2047.

[2]A standard minor line check for foreign material in the oil sumps and fuel screens accomplished every 50 flying hours.
[3]The intersection of the southwest leg of Tri-City low frequency radio range and the 275-deg. radial of the Tri-VOR—3 mi. southwest of the airport.
[4]The intersection of the northeast leg of the Tri-City low frequency radio range and 344-deg. radial of the Tri-VOR—9 mi. northeast of the airport.

At approximately 2052, after Flight 308 had failed to respond to any radio calls, the controller initiated accident search procedures. The pilot of Piedmont Flight 383 flew in the ILS approach area on his departure from Tri-City in an attempt to locate Flight 308 which was presumed down. He did not see any sign of the aircraft and reported that the reduced visibility and low ceiling in the area of Holston Lake prevented any further search.

The wreckage was located Jan. 9, 1959, about 1130 by a Tennessee Air National Guard aircraft on the northwest side of the Holston mountain range 18.75 naut. mi. east of the Tri-City Airport and 1.25 naut. mi. north of the ILS localized path. The terrain in which the aircraft crashed was extremely rugged and heavily wooded. A ground party led by Civil Air Patrol personnel reached the scene late in the afternoon after an arduous climb up the snow-covered mountainside and reported back that there were no survivors. A study of the impact area revealed that the aircraft, while on a course of 235 deg., first struck several trees which severed the left wing approximately 21 ft. from the tip and destroyed a portion of the horizontal stabilizer.

Impact Marks

It could be seen from the initial impact marks that the aircraft was in level flight longitudinally with an angle of bank to the right of less than 10 deg. when it struck the trees growing on the 35-deg. slope, at an elevation of 3,140 ft. near the crest of the mountain. As it continued into the trees, parts separated and finally the outer right wing panel was severed by another tree. The remainder of the aircraft continued over the crest of the hill without hitting the ground. Its forward motion was then stopped by contact with several large trees and it fell to the ground in an upright position. The cabin section of fuselage with the empennage attached then rolled 180 deg. to the right and came to rest inverted across the stub of the right wing.

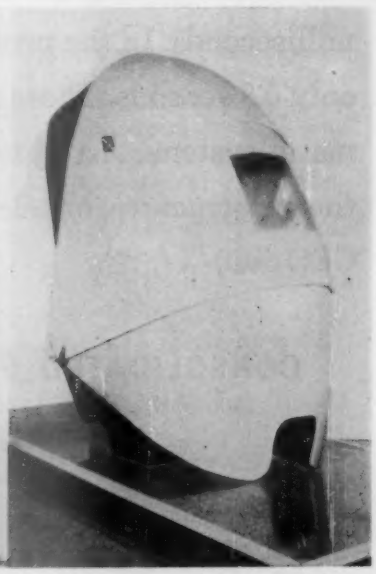
The left engine separated from the aircraft during the impact sequence and came to rest at the crest of the ridge. The left propeller and nose section had broken away from the engine and had fallen about 20 ft. back along the crash path. The right propeller separated during the first 135 ft. after initial impact and came to a stop about 35 ft. behind the main wreckage. The right engine continued forward when the aircraft was stopped by the large trees and came to rest about 300 ft. down hill from the wreckage.

Intense Fire

An intense fire ensued in the main wreckage consuming the nose section, cabin sides and belly of the fuselage, the nacelles, and forward part of the wing center section. Inasmuch as there was no evidence of fire or heat on the trees, underbrush, or pieces of wreckage along the crash path, this fire must have occurred after the wreckage stopped.

All components of the aircraft structure were accounted for in the wreckage area. All control surface hinges and control surface bell cranks were located and all damage was determined to have been the result of impact forces. The control system cables were traced and found to be intact with the exception of those points at which the outer wing panels had separated. The landing gear and flaps were in the fully retracted position and, as near as could be determined, all trim tabs were in the neutral position.

The left propeller was found almost at the top of the ridge. It had broken from the engine at the nose section and had lodged in



Escape Capsule Designed for Supersonic Vehicles

Escape capsule designed to separately eject pilot and crew of supersonic aircraft was developed by Goodyear Aircraft Corp. and is being evaluated by Air Research and Development Command's Wright Air Development Center. Inflatable bags float capsule in water. Capsule contains equipment for 72-hr. survival. Unit is designed for ejection at 90-300 kt. airspeed. Two drogue chutes slow capsule so 32-ft.-dia. recovery chute can be deployed.

data from a wind tunn

F-106 model in Convair's supersonic wind tunnel at San Diego, California.

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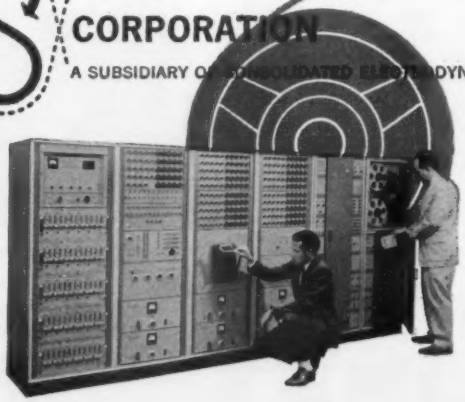

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an upright position against a tree. All three blades remained attached to the hub but were bent at various angles and about eight inches of the tip of the No. 1 blade was broken off. The propeller dome shell was broken and the piston was partially collapsed by a load on its forward end. Upon disassembly the low pitch stops were found to be crushed by the rotating cam stops at impact. The dome piston was at 24 deg. Only one of the three blade shim plates bore markings sufficiently distinct for blade angle correlation. It indicated a blade angle of 24 deg. at impact.

The left engine was found lying on its nose section near the crest just a few feet from its propeller. Two cylinders and rocker assemblies were broken away from the engine by impact. The power section was inspected and was found to have had adequate lubrication. There was no evidence of abnormal heat discoloration, flailing, or interference of the moving parts. The nose case was broken open and the reduction gears were separated from the engine. They appeared normal and adequately lubricated. All engine accessories were examined and no evidence of operating difficulty was found.

All three blades of the right propeller were bent and the tips of No. 1 and 2 were broken off. The propeller dome shell was intact and the piston was positioned at 26 deg. The shim plates bore impact markings as follows: No. 1 at 15 deg.; No. 2, two marks at 24 deg. and 18 deg.; and No. 3 at 23 deg.

Engine Examination

The right engine rolled about 300 ft. down a slope from the main wreckage. Several of its cylinders and rocker assemblies were broken off by impact. Examination of the power section showed adequate lubrication and there was no evidence of operating difficulty. The nose case was broken open but the gears appeared to be normal with adequate lubrication. The accessories were examined and none indicated evidence of malfunction prior to impact.

The main oil screens and sump plugs of both engines were examined and found to be free of metal particles. In addition, the main fuel screens for each engine were found to be clean and undamaged. All damage noted to both powerplants was the result of impact forces. There was no fire damage either in flight or after impact on either engine.

Maintenance records indicated that both the airframe and powerplants had been maintained in accordance with all applicable regulations. There were no outstanding discrepancies and no maintenance carry over items which might have affected the airworthiness of the aircraft.

The radio equipment installed in N 18941 was subjected to heavy impact forces and fire which followed. The two VORs (VHF navigation receivers) with which the aircraft was equipped were recovered. By comparing the pilots' tuning knob with an undamaged one it was determined that VOR No. 1 was tuned to 109.9 mc. Inspection of the receiver confirmed this setting which is the frequency of the Tri-City ILS localizer. The tuning knob on VOR 2 indicated 111.3 mc. but no reading could be obtained from its receiver because of the extensive damage. This frequency is not one used for any radio navigational facility in the Tri-City area.

The two glide slope receivers installed were recovered but both were damaged so extensively that no settings or other useful information could be obtained.

There was also one ADF and one low frequency receiver with fixed loop on the aircraft. Both of these receivers were found. The ADF receiver was badly damaged and burned but it was possible to determine that it was tuned to 221 kc., the Tri-City low frequency radio range. No positive determination could be made for the low frequency receiver. However, it appeared to be set between 324 kc. and 349 kc.

The single VHF transceiver was tuned to 119.5 approach control frequency and the single HF transceiver was tuned to a company operating frequency.

The marker beacon receiver was recovered in fairly good condition. However, all but one tube were missing from the set. As none of the tube sockets were damaged and no pieces of tubes were found inside the receiver, it is presumed some souvenir hunter had appropriated them. After the tubes were replaced, and one connection which had been damaged at impact was repaired, the receiver operated and produced both an aural and visual signal.

The Tri-City Airport has standard instrument landing system equipment. Both the localizer and the glide slope are equipped with dual transmitters with a provision for automatic switch-over in the event of a malfunction of any kind in the main equipment. They are also provided with standby power units in the event of commercial power failure. Finally, both the localizer and glide path are self-monitored and any malfunction in the equipment will actuate a red light and sound buzzer in the tower.

In addition, the ILS installation includes an outer marker and a middle marker beacon. These VHF marker beacons are located on the ground in line with the localizer path at specific distances from the end of the runway to enable the pilot to orient himself in relation to the distance to the runway threshold. As an additional assistance to the pilot there is a low frequency compass locator at each marker beacon location which is normally utilized by means of the ADF. The compass locators for the middle and outer markers transmit nondirectional signals on frequencies of 201 kc. and 239 kc., respectively.

The marker beacons and the compass locators are single-transmitter installations and do not have standby power provided. However, like the localizer and glide path they are automatically monitored and any malfunction will actuate equipment failure alarms in the tower. The components of the ILS and the compass locators were functioning properly on the night of the accident. No such equipment failure alarm occurred in the tower. In addition, another Southeast flight executed an ILS approach subsequent to Flight 308 and reported the system normal. A flight check by the Federal Aviation Agency was made of all the Tri-City radio facilities the following day and all were operating normally.

At the Tri-City Airport the middle marker and outer marker were located on the localizer path 5 and 3.7 naut. mi., respectively, east of the approach end of Runway 27. Eight and six-tenths naut. mi. farther east on the localizer path (12.3 naut. mi. east of

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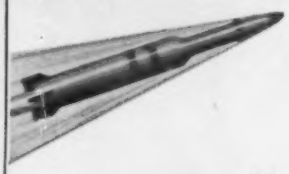

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the runway threshold) there is another low frequency nondirectional "H" facility known as the Emmett beacon. Two additional radio aids are a low frequency radio range and a VOR (VHF omni directional range).

There are two specified altitudes at which procedure turns are authorized for an ILS approach to Tri-City. Originally the minimum altitude at which the turn could be made was 5,500 ft. within 10 mi. east of Emmett "H." Later an alternative procedure turn was authorized at an altitude of 3,000 ft. within 5 mi. east of the outer marker. The 5-mi. restriction is necessary because beyond this area the terrain rises rapidly to elevations well above 3,000 ft.

According to a company witness, the Southeast training program covered the Tri-City ILS procedures. He said that the procedure taught is to cross Gray intersection, proceed to the middle marker, and thence to the outer marker. All Southeast pilots have been instructed that the flying time from Gray to the outer marker is approximately three minutes. They are also instructed that the procedure turn must be started 30 sec. after passing the outer marker to ensure that it is completed within the 5-mi. radius of the LOM (outer marker and compass locator). Shortly after the accident Southeast Airlines sent the following message to all of its pilots: "Effective immediately positive identification of Gray intersection will be made utilizing the facilities that comprise the intersection. Namely, the 275 deg. radial of TRI-VOR and Southwest course of TRI-LFR (Tri-City Low Frequency Range). Descent below 5,000 prohibited until positively identified."

It has been the company practice to use the 344-deg. radial of the Tri-City VOR which crosses the localizer about 6½ mi. east of the outer marker as an additional safety measure to assist the pilot in remaining within a safe area.

The company witness further said that the ADF is not an essential piece of radio equipment for the ILS procedure. However, he said a properly operating ADF is required by Civil Air Regulations and company regulations for flight in instrument weather conditions. In such conditions the company considers it a "no-go" item. He said also that when malfunction occurs to this unit or other such item, company policy requires that it be noted in the aircraft log and corrective action be taken before originating a flight segment. As stated before, Capt. Bond made no entry in the flight log concerning the ADF although he was certain that it was not operating. Records indicate that no maintenance was performed on the receiver during the stops at Nashville or Knoxville.

Eyewitnesses Sought

During the investigation many persons were interviewed in an attempt to locate witnesses to the flight of the aircraft. Many saw aircraft during the evening; however, none was able to establish the time of his observation with sufficient accuracy to be of great value to the Board in plotting a probable path for Flight 308.

A meteorologist, who was on duty at the Tri-City Airport, testified concerning the weather conditions which existed at the time of the accident.

He said that the ceiling was 1,700 ft. overcast with scattered clouds at 1,000 ft. The visibility was 5 mi. The witness said a study of the information available to him indicated that from Bulls Gap to Tri-City at 5,000 ft. the flight would have been operated in instrument weather conditions. He estimated the en route winds would have been north-northwest at approximately 20 kt. The Piedmont captain of Flight 383 estimated winds which he encountered at 5,000 ft. were from the west-northwest at 25-30 kt.

ANALYSIS

Examination of the wreckage of N 18941 revealed no evidence of any failure or malfunction of either the airframe or the powerplants. There was no indication of fire in flight and all components of the airframe were accounted for in the wreckage. Both engines and propellers were capable of normal operation prior to impact. From this evidence it is clear that no structural or mechanical failure or malfunction occurred which in any way contributed to the cause of this accident.

Examination of the radio equipment of N 18941 indicated that the crew was not utilizing all the facilities available to them. First, the No. 2 navigation receiver was not tuned to a frequency of any facility in the area. It is therefore presumed that the No. 2 navigation receiver was not in use. Normally this receiver would be tuned to the TRI-VOR (117.7 mc.) and utilized to determine the backup radials which define the safe easternmost limit of the procedure turn area.

Second, as near as can be determined the low frequency receiver was tuned between 325 kc. and 349 kc. Again, this frequency is unrelated to that of any facility in this area which could be utilized by this receiver. The closest frequency of any local facility to this setting is the Emmett "H" radio beacon which is 320 kc. It is extremely doubtful that this receiver would be utilized on Emmett "H," however, as this homer is nondirectional. Normally the low frequency receiver is tuned to the TRI low frequency radio range, 221 kc., and used as another aid in determining the aircraft position in relation to the radio range legs. It is clear this receiver was not being used on the TRI-LFR because it is extremely improbable that impact forces could move the frequency over 100 kc.

Third, the ADF was tuned to the radio range frequency of 221 kc. While en route from Knoxville to Tri-City it would be expected that the radio compass would be used to follow the airway. However, after the aircraft had reached the vicinity of the airport and an approach on the ILS was started, the crew would normally tune the ADF to the nondirectional compass locator associated with the middle or outer marker. These frequencies are: 201 kc. and 239 kc., respectively.

Another alternative would be to tune the ADF to the Emmett "H" facility for assistance in establishing the safe easternmost limit of the procedure turn area.

Two inferences arise because the radio compass was not tuned to the frequency of a facility which would assist in determining position along the localizer. The first is that the automatic direction finding feature was not functioning or was not

being used. The second is that the radio compass was entirely inoperative and neither the visual presentation nor the audio signals could be received.

During the last transmission from the flight, the pilot stated that ". . . his ADF was acting up." In addition, Capt. Bond testified that he was unable to receive either visual or aural signals on the ADF prior to landing at Nashville. The evidence also indicates that he informed Capt. Gollmier of the malfunction at Nashville but that no maintenance was performed there or at Knoxville. It is therefore reasonable to presume that the ADF was completely inoperative and further that the crew was aware of the situation prior to takeoff from Nashville.

Selector Position

It should be noted here that there is a remote possibility that a sightseer at the crash site could have altered the setting found on the No. 2 navigation receiver frequency selector; it is also possible that the frequency selector was moved as a result of heavy inertia forces. If this were true and the receiver was being used on the TRI VOR, the pilot should have been acutely aware of his position. As for the ADF, because of the fire markings on the dial and exposed gears, investigators determined that the frequency setting had not been altered. It is clear that this receiver was tuned to 221 kc.

Flight 308 reported as being over Gray intersection at 2024. About 2032, the conversation with the tower took place. Before completion of that conversation the aircraft crashed. This would place the accident, as near as can be determined, at 2032. A study was made to determine the airspeed which would have been required for the aircraft to traverse the distance from Gray to the crash site in eight minutes. Knowing the straight-line distance from the crash site to Gray, and the wind, and assuming a standard procedure turn and standard rate turns throughout, it was possible to calculate, mathematically, this airspeed.

These calculations revealed that N 18941 would have had to have had an airspeed of 180 kt. or a groundspeed of 191 kt. to travel from Gray intersection to the accident site in the eight minutes. Obviously, the speed is much too high for a DC-3, especially while maneuvering prior to an ILS approach. From the calculations it is evident that N 18941 could not have been over Gray at 2024, as it reported.

Airspeed Checks

The Board therefore selected two airspeeds, 130 kt. and 110 kt., as representative maneuvering speeds at which an ILS procedure would be flown. Substituting each of these speeds in the computations, and starting at the crash site working back toward Gray, it was possible to determine two lines of position along one of which N 18941 had to be located eight minutes before the crash. It was immediately discerned that the 110-kt. line of position could not, in all probability, be correct because it was impossible to correlate the en route reporting times to it. However, the 130-kt. line of position appears to be consistent with all the known facts.

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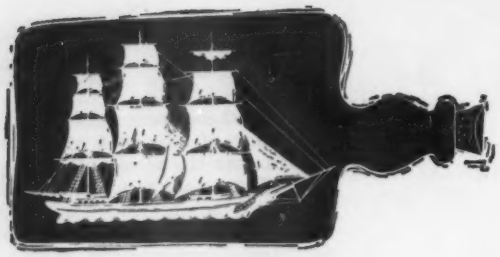

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which is 30.5 mi. from Piedmont, at 2010, it can be seen that the groundspeed of the aircraft was 152 kt. The next position report was over Gray, 32 mi. from Bulls Gap. At a groundspeed of 152 kt., this segment should have taken 12.5 min. However, the flight did not report over Gray until 2024, 14 min. after passing Bulls Gap. At this same groundspeed the airplane would have traveled 35.5 mi., or at least 3.5 mi. closer to the accident site than Gray. In other words, when the flight reported over Gray it was actually 3.5 mi. or 1.5 min. beyond Gray. By plotting this distance (35.5 mi. from Bulls Gap) on a chart, it was found to cross the 275-deg. radial of the Tri-City omni at the same approximate point as the line of position calculated for a maneuvering speed of 130 kt. It can be seen that a course from Bulls Gap to this point would pass approximately two miles east of Gray.

As stated before, the Board believes that the ADF was inoperative as reported by Capt. Bond. It further believes that the flight from Knoxville to Tri-City was made in instrument weather conditions without using the low frequency radio aids which define Green Airway 5. There was evidence at the public hearing that in some instances pilots were using the intersection of the 65-deg. radial of the Knoxville VOR and the 275-deg. radial of the Tri-City VOR as Gray intersection. The intersection of these radials is very indefinite because of the distance from Knoxville and it is possible to receive an indication which could place it several miles east of Gray.

On the basis of all this evidence the Board believes that the crew of N 18941 flew from Knoxville to Tri-City, utilizing the Knoxville VOR, and attempted to locate Gray without the aid of the low frequency radio. As will be recalled, the winds aloft were reported to be from the north-northwest and would tend to drift the aircraft east of its course. It is clear that all of these factors combined to cause the airplane to arrive at the position which was reported as Gray intersection.

Intersect Attempt

Had the aircraft been at Gray the correct procedure would have been to continue on the same heading as the low frequency range leg (65 deg.) to intersect the localizer at the middle marker and then to turn to a 90-deg. heading to track outbound past the outer marker. It is probable that the crew, thinking it was in the vicinity of Gray, followed the normal procedure for intercepting the localizer. From the position it has been shown N 18941 was over when it reported Gray, a course of 65 deg. to the localizer would pass south and east of the outer marker. Thereafter, without receiving the outer marker and without the use of the low frequency receivers or the No. 2 navigation receiver, the flight would be unable to determine its position along the localizer.

From the calculations which were mentioned above, the time interval from the Gray report to the beginning of the procedure turn was found to be 5 min. and 45 sec. Normally, a procedure turn would have been started approximately 3 min. and 30 sec. after passing Gray. Even if the

flight had been over Gray, as it reported, to continue 2 min. and 15 sec. beyond the normal flying time to the outer marker would place the procedure turn well beyond the authorized 5-mi. limit and probably beyond the 5-mi. buffer area which is provided as a safety zone east of the procedure turn area. Actually, Flight 308 flew for a period of 5 min. and 45 sec. from the position, which was erroneously reported as Gray, before starting its procedure turn. Had a procedure turn been started 3 min. and 30 sec. after this report, as is normal, it is probable the accident would have been avoided.

Familiar Route

It is apparent that the flight finally realized it had missed the outer marker and must have realized they were east of it, because they started their turn. Both crew members were familiar with the Tri-City Airport and facilities, and both must have been well aware of the terrain variations in the area. When they realized they were east of the outer marker an unknown distance, the first and only proper action was to execute a missed-approach procedure, climbing to 5,500 ft. on the west course of the localizer.

It is assumed that the flight did receive the localizer indications. However, it did not receive an indication of the outer marker. The transmission from the flight asking if the glide slope was operating indicates that this instrument was not operating properly or that they could not rationalize the indication from it with their supposed geographic location. If the localizer had been intercepted to the west of the outer marker, the glide slope indicator would have been at a full fly-down deflection because the aircraft would have been above the glide slope. It would have changed from full fly-down to full fly-up as the aircraft proceeded eastward on the localizer past the outer marker.

Possible Factors

It is possible that either the glide slope indicator or the outer marker beacon did not function properly. It may be that the crew concluded they were inoperative. In this event they were wrong in continuing the approach.

Actually, the aircraft intercepted the localizer east of the outer marker. At this point, the glide slope indicator would have been at a full fly-up deflection because the glide slope was above the aircraft. It may be that the crew was confused when, thinking they were west of the outer marker, they received an indication opposite to that expected. It is also possible that high terrain intervening between the transmitter and the aircraft may have blocked the signal (which is VHF and line-of-sight) from being received by the aircraft, causing a flag to appear in the deviation indicator of the aircraft.

In either case the Board believes the crew had a clear duty to discontinue the procedure immediately and execute the approved missed approach.

Several other factors have been considered by the Board as equally important in the analysis of this accident. First, company regulations specifically require an operable ADF for all flights dispatched in accordance with instrument flight rules. Next, the operations specifications issued by the Administrator, Federal Aviation Agency, clearly set out the equipment requirements for an ILS approach procedure: ". . . (a) An ILS instrument approach procedure for the purpose of conducting a straight-in approach to the ILS runway is authorized if (1) no more than one component of the ILS (other than the localizer) is inoperative or the signals therefrom cannot be received (2) all other components of the ILS and related airborne equipment are in normal operation . . . (b) an ILS instrument approach procedure for the purpose of conducting a straight-in approach to the ILS runway is authorized if (1) the localizer and either the outer marker or outer compass locator and related airborne equipment are in normal operation. . . ."

Absence of Indications

It is impossible to rationalize the pilot's thoughts concerning the absence of outer marker and glide slope indications. He may have believed either of the facilities (including ground or airborne equipment) inoperable. The Operations Specifications issued by the Administrator of the Federal Aviation Agency clearly limit the use of the ILS to facilities in which both functions are operable. Accordingly, it would have been necessary that the approach be abandoned. On the other hand, had he considered that both functions were operating satisfactorily he had no alternative

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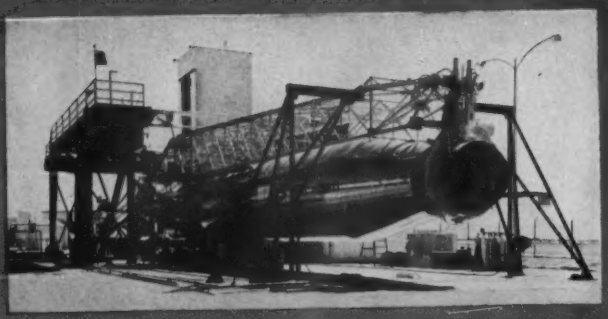

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but to conclude he was too far east of the outer marker to have used the minimum altitude specified for a procedure turn within 5 mi. of the outer marker.

CONCLUSIONS

On the basis of all the evidence, the Board concludes that the radio compass (ADF) was inoperative and could not be used either for navigation along the low frequency radio range or receive the compass locators associated with the ILS. Further, the Board believes this condition was known to the crew at Nashville. It is also obvious that they did not use the other low frequency receiver aboard the aircraft because the flight was not on Green Airway 5 as it neared Tri-City. As stated before, the Board believes that the 65-deg. radial of the Knoxville VOR was used to navigate to Tri-City and was also used to locate Gray intersection. It is concluded that the flight was east of its intended course and reported as being over Gray when it was actually several miles east of Gray. This conclusion is inescapable in view of all the known facts.

The Board further concludes that the crew, without realizing their actual position, followed the usual procedure for intercepting the localizer and in so doing passed to the south and east of the outer marker. After missing the outer marker, the only way position along the localizer could have been determined was by means of the Tri-City VOR. It is evident that the crew did not use this facility as an aid in the procedure.

A faulty indication or malfunction of equipment could not be used to mitigate the pilot's responsibility in these circumstances. Several additional facilities were available for a cross-check if in his mind he thought the outer marker or the marker beacon receiver was inoperative.

ILS Conditions

One of the provisions in the operations specifications issued to the company by the FAA clearly establishes the conditions under which an ILS can be executed. Those specifications make it clear that an ILS approach may not be commenced if more than one component of the ILS is inoperative or the signals cannot be received. Here N 18941 could not receive the compass locators and did not receive the outer marker. Although it may have received the glide slope signal it is obvious the crew did not or could not understand the indications.

The foregoing procedures are contained in the operations specifications issued to the carrier by the administrator of the Federal Aviation Agency in accordance with Part 40.18 of the Civil Air Regulations. This regulation prohibits any operation in violation of these specifications. Part 40.364, moreover, fortifies this provision by requiring that the ILS procedures authorized in these operations specifications be adhered to. A determination as to when a procedure turn may be conducted at Tri-City east of the outer marker within 5 mi. cannot be made without identifying the outer marker in passing.

The Board cannot conceive of any justification for the manner in which this flight was conducted. The purpose of the

company regulation requiring an operable ADF for IFR flight is to prevent just this type of accident. The Board concludes that the malfunctioning ADF should have been noted in the aircraft log. Ample facilities were available at Nashville and Knoxville for corrective action to be taken before takeoff.

When Capt. Gollmier chose to continue the flight in violation of company regulations it would have been expected that he used all other radio equipment available to him. This was not done.

All the radio aids in the Tri-City area are maintained by the federal government for the use of all pilots. While the use of all radios may not be mandatory for IFR flight, good operating practices dictate a maximum cross-check of all available facilities. If Flight 308 had utilized either the low frequency receiver on the Tri-City range or the No. 2 navigation receiver on the VOR, this accident would in all probability have been avoided.

PROBABLE CAUSE

The Board determines the probable cause of this accident was the failure of the pilot to identify Gray intersection properly and his decision to continue an ILS approach contrary to company and regulatory procedures.

By the Civil Aeronautics Board:

James R. Durfee
Chan Gurney
Harmar D. Denny
G. Joseph Minetti
Louis J. Hector

SUPPLEMENTAL DATA

The Civil Aeronautics Board was notified of this accident at 2200, Jan. 8, 1959, and an investigation was immediately initiated in accordance with the provisions of Section 701 (a) (2) of the Federal Aviation Act of 1958. A public hearing was held in Kingsport, Tenn., Mar. 2 and 3, 1959.

Southeastern Aviation

Southeastern Aviation, Inc., doing business as Southeast Airlines, is a Tennessee corporation. The corporation was formed in August, 1956, and applied to the State Bureau of Aeronautics for a certificate of convenience and necessity for the carriage of persons and property within the State of Tennessee. After qualification, the certificate was issued Dec. 18, 1956, for designated intrastate routes, including the route being flown in this instance. Subsequently, Southeast was given a series of check flights and issued Commercial Operator Certificate No. FW-15 (c) by the Civil Aeronautics Administration (now Federal Aviation Agency). Scheduled intrastate operations began Feb. 8, 1957, and have been continued in accordance with the provisions of Part 40 of the Civil Air Regulations.

Flight Personnel

Capt. Robert L. Gollmier, age 36, was employed by Southeast Feb. 22, 1957, as a copilot. May 29, 1957, he was promoted to captain. He held a currently effective airman certificate with an airline transport rating, type ratings in the Douglas DC-3, and Convair CV-240, CV-340, CV-440 aircraft, and instrument rating. Capt. Gollmier had a total of 7,214 flying hours, of which 2,674 were in DC-3 equipment. He had a total of 449 hr. of instrument time, 42 hr. of which had been accumulated in the preceding 90 days. He also had executed 38 ILS approaches within the preceding 90-day period. He had received his last line check Oct. 16, 1958, and his last semiannual proficiency check Nov. 10, 1958. His last first-class physical examination was given Sept. 25, 1958.

Mr. Robert M. Irwin, age 28, was employed by Southeast Airlines Aug. 10, 1958. He held a currently effective airman certificate with a commercial pilot rating for single- and multi-engine land aircraft, and an instrument rating. Mr. Irwin had a total of 2,367 flying hours, of which 432 were in DC-3 equipment. He had a total of 202 hr. of instrument time, 26 hr. of which had been accumulated in the preceding 90 days. He also had executed 13 ILS approaches within the preceding 90-day period. He had received his latest line check Aug. 12, 1958, and his last instrument check Aug. 10, 1958. His last first-class physical examination was given Aug. 7, 1958.

Miss Wanda C. Nalley, age 20, was employed by Southern Airlines Jan. 1, 1958. She had completed a correspondence course at Weaver Airline School and had received 40 hr. of ground school training with Southeast Airlines. Her last line check was given Aug. 7, 1958. Her last physical examination was given Dec. 30, 1957.

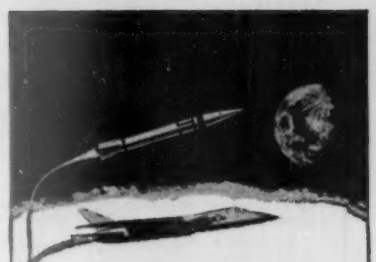
N 18941, a Douglas DC-3A, serial No. 2007, was manufactured Apr. 8, 1958. It was purchased by Southeastern Aviation, Inc., on Nov. 19, 1956. At its departure from Memphis the airframe had a total time of 56,755.9 hr. The time since its last overhaul was 7,242 hr. The aircraft had flown 48 hr. since its last No. 1 inspection on Dec. 30, 1958, and 132 hr. since the last No. 3 inspection Dec. 15, 1958. Records showed that the aircraft was maintained in accordance with applicable regulations and there were no uncorrected discrepancies or carry-over items of maintenance. The aircraft was equipped with Pratt & Whitney 1830-92 engines and Hamilton Standard propellers 23E50-505.

Voice Radio Devices Improvement Studied

Blonder-Tongue Laboratories of Newark, N. J., will conduct research on radio transmission of the human voice and will develop an experimental device to improve the intelligibility of aviation voice communication under a $55,000 Federal Aviation Agency contract.

A three-month study will be made of the human voice and the acoustical environment of air traffic control activities. Data will be analyzed and prototype equipment constructed so voice tests can be conducted.

Voice intelligibility equipment will subsequently be installed in the headsets and microphones of FAA controllers for field tests to be made at FAA's National Aviation Facilities Experimental Center, Atlantic City, N. J.



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For details, write to:
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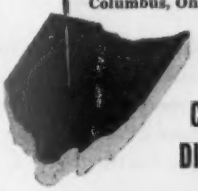
Engineering Personnel
Manager, Box AW-491
North American Aviation, Inc.
Columbus, Ohio.



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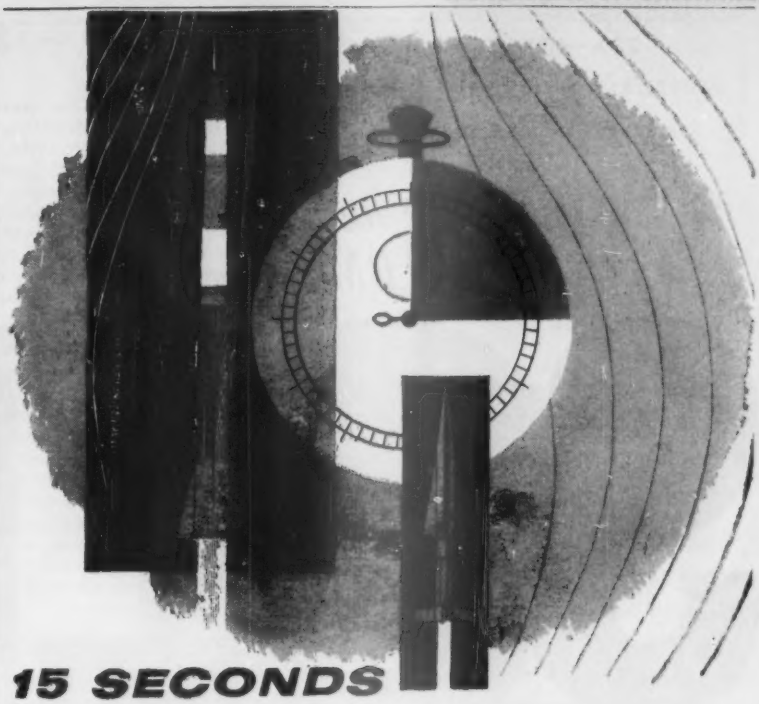

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Of Aviation Week published weekly at Albany, New York for October 1, 1959.

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5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: 72,778.

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By JOHN J. COOKE, Secretary.

Sworn to and subscribed before me this 10th day of September, 1959.
[SEAL] JANET A. HARTWICK.
(My Commission expires March 30, 1961)

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LETTERS

Battle for Space

Your editorial of Sept. 21, "Lessons of Lunik," was good. However, I believe a very significant factor of Lunik has been overlooked. I refer to the attitude of the American people in regard to continued Soviet space "firsts." Remember the tremendous uproar over Sputnik I? Now with Lunik we should be even more concerned because we are lagging farther behind. But, no—we seem to have become satisfied with second place.

We are a government of pressure. If the people will not demand first place in space, we will never have it. In fact, once in the habit we may accept second place in all international endeavor. And this is what scares me—the American people so complacent and full of luxury that they are unwilling to make the sacrifices necessary to win the really significant struggle of our time, the battle for space. It could well be the beginning of the end.

THEODORE M. SPRAGUE
Corning, N. Y.

Mr. K's Itinerary

The airline pilots that aren't allowed to go back to the bathroom think they have problems?

Get a load of this little jewel FAA regulation, quoting the Los Angeles Examiner of Sept. 17, 1959:

> "No aircraft shall be flown within a distance of one statute mile horizontally or 3,000 ft. vertically of any motorcade route along which Mr. Khrushchev and his party are traveling or a place at which the chairman and his party are present."

Well, fine. Not wishing to have Mr. Quesada's boys snapping at me, I phoned the local FAA and asked for Mr. K's arrival time, routes, and itinerary. This, I was informed, was not only not available but was real secret stuff. A subsequent call to the local FBI confirmed this, along with a query (Dragnet voice) just why I was so interested?

E. D. WEINER
Los Angeles, Calif.

Space Ranks

Knowing your intense interest in and cognizance of aviation and space subjects, I am forwarding this document, which appeared in my "in" box at the Pentagon without covering letter or explanation. You will note that it bears no security classification. It has been processed by the Office of Security Review of the Assistant Secretary for Public Affairs of the Department of Defense and adjudged fit for release to the public, as evidenced by the fact that it bears the following rubber stamps:

"No objection to publication on grounds of military security. (As amended.)"

"Review of this material does not imply Department of Defense indorsement of factual accuracy or opinion."

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

"Clearance of this document does not include any photograph, figure, exhibit, caption or other supplemental material not specifically cleared by the Department of Defense. (As amended.)"

Otherwise, of course, I would not pass it on to you, since I am now a USAF lieutenant colonel and have hopes of someday being promoted to Planeteer if this new system is finalized.

(*Note: The document is reproduced below—Ed.*)

Ranks of the United States Space Force*

Galacteer	Four Star**
Liftenant Galacteer	Three Star
Majoris Galacteer	Two Star
Solardeer	One Star
Planeteer	Colonel
Liftenant Planeteer	Lt. Col.
Orbiteer	Major
Rangeer	Captain
1st Liftenant	1st Lt.
2nd Liftenant	2nd Lt.
Stageman	CWO
Jr. Stageman	WO
Senior Blasteer	CMS
Jr. Blasteer	SMS
Blasteer	M/Sgt.
Chief Nozzleman	T/Sgt.
Jr. Nozzleman	S/Sgt.
Padman 1st Class	A/1C
Padman 2nd Class	A/2C
Padman 3rd Class	A/3C
Basic Padman	Basic Airman

*The Space Force salute will begin with the open palm faced outward at waist level and brought upward with increasing acceleration, snapping crisply and smartly to apogee.

**There will be no restriction on a member of the Women's Space Force to keep her from reaching the rank of Galacteer provided she is prepared to go that far. (AF Regulations restricted women to the equivalent rank of Planeteer.)

NAME WITHHELD BY REQUEST

Ejection Trainers

We would like to take this means of calling attention to an inaccuracy which appeared on p. 139 of the Sept. 7 issue of your magazine.

In a cutline on a B-58 ejection seat trainer, it was reported ". . . the unit is the first of its kind to be used by the Air Force."

In reality, however, as early as October of 1953 a Boeing seat ejection and canopy trainer for the B-47 was delivered to the Air Force.

The B-47 seat ejection and canopy trainer demonstrated the operation of the pilot's ejection seat, canopy and control column functions in support of Air Force maintenance and air crew personnel training. The seat had an upward travel of 32 in. with a controllable ejection force up to 9g. The entire ballistic system was redesigned to operate from high pressure air while retaining the external appearance and functions of the actual ballistic items. Subsequent reorders resulted in the delivery of 21 trainers.

In addition, nine trainers designed similar to the above were delivered to the Air Force for downward ejection from the B-47.

JACK L. WECKER
Chief, News Bureau
Boeing Airplane Co.
Wichita Division
Wichita, Kan.

Polaris Chambers

Appreciate fine picture Ryan Polaris rocket chambers (AW Sept. 28, p. 37) but caption should read significant 305,000 psi., instead of puny 35,000.

Added note: Ryan now up to 350,000 psi. and building full-scale Polaris rocket chambers.

BILL BROTHERTON
Public Relations Manager
Ryan Aeronautical Co.
San Diego, Calif.

Mechanic Services

I am sending the following letter to William B. Davis, Director, Bureau of Flight Standards:

"Under the proposed ruling of Civil Air Regulations Draft Release No. 59-11, the services of thousands of A & P mechanics will be seriously curtailed, in that all release privileges in regard to minor alterations will be eliminated.

"A large portion of the credit for advancement in aviation and in the component parts of aircraft belongs to the A & P's who were curious enough to find out why seals leaked (designed by top engineers), why cylinders got too hot (again systems designed by top engineers), why wheel bearings "froze" in normal service.

"The A & P, in effect, is a sort of field engineer for every manufacturer today, suggesting changes, asking the big questions "why," "what happened," and "what is the best fix and/or cure."

"The free-lance A & P is subservient to no manufacturer and generally cannot afford any mistake, no matter how small. Do not sell him short. Do not put extra "paper work" obstacles in his path."

I urge every pilot, every mechanic, every engineer, in short every person interested in aviation, to get a copy of this draft release, read it, weigh the wording carefully in all aspects, and write their conclusions as requested in the form letter.

C. C. NELSON, JR.
Seattle, Wash.

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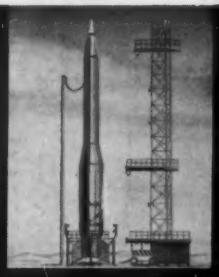

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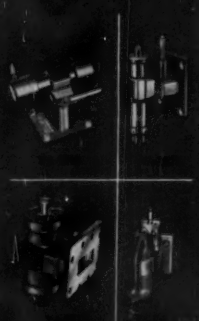
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